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Letting nature take its course

Managing regrowth in Australia's changing rural landscape: a social phenomenon

Protecting regrowth vegetation in Queensland: a case study in sustainable land management

Regrowth in south-western Australia: challenges and opportunities

Regrowth and conservation in New Guinea

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SPECIAL THEME: REGROWTH – A POSITIVE FORCE FOR PLANT CONSERVATION

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Front cover: UWA Future Farm near Pingelly in Western Australia's wheatbelt. Photo: Richard Hobbs

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From the Editor

Regrowth: a positive force in plant conservation

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Regrowth is a natural process, but it's also one which has deep cultural resonance everywhere in the world. In Brazil, for example, the native American word for regrowth is postulated to be the origin of the word *capoeira*, the incredible Afro-Brazilian musical martial art/dance form. The beautiful pine barrens and oak woodland of central Wisconsin, immortalized in Aldo Leopold's Sand County Almanac, were partly cleared and then abandoned during the Dust Bowl. Today in New Guinea, as Paul Sillitoe describes in this issue, regrowth is integral to the production of useful biodiversity of surprising variety.

The predominantly Anglo-Australian environment movement shares a common origin to regrowth in the Australian landscape. Both the ecological process of regrowth, and the socio-political environment movement, are responses to disturbance, such as colonial land clearing and resource extraction. But like regrowth, the environment movement shouldn't focus only on preventing exploitation. It's also about positive forces, both human and natural, which can repair some of that damage.

We need to harness the natural power of regrowth, to understand where active intervention is really needed to achieve some specific conservation benefits. This issue of APC explores the social and the natural aspects of regrowth, and presents a sampling of thinking from around the country and from government, non-governmental organizations, consultants, and scientists.

Paul Adam suggests there are lessons to be learned from succession of plant communities following mining, while Paul Gibson-Roy discusses the potential for natural regrowth to be occurring simultaneously with restoration efforts. Ian Lunt and colleagues, working in New South Wales and Victoria, point out that management of regrowth, like our earlier attitudes toward remnant vegetation, will be influenced by social factors, while Rachel Standish outlines the barriers which limit natural resilience in much of the Western Australian mallee belt. When reading Brad Witt and Bob Beaton's account of mulgalands management, we are reminded that woody vegetation isn't the whole story.

Over the past few decades, governments across Australia have moved to regulate clearing of native vegetation, a challenging job to say the least. In most states regrowth vegetation can be cleared, as defined by the legislation in that state and under certain circumstances. In this issue Ben Lawson explains that the most recent legal frontier is the passage of stronger protections for "endangered regrowth" in Queensland. Maria Matthes and Mark Robinson call for stronger consideration of the values of regrowth in development assessment.

Regrowth is also topical because of its potential in managing atmospheric carbon while concurrently promoting biodiversity. John Dwyer provides some research results on this in the Brigalow Belt. Greening Australia have a policy aimed at ensuring that the economic potential inherent in this fact links back to outcomes for native trees in the ground, which David Freudenberg and David Carr, with help from Michael Vyse, summarize.

This edition also includes results of research on the biodiversity benefits of livestock exclusion from Western Australian remnant woodlands by Rachel Standish, Susan Prober and Georg Wiehl; decline of Widgeon Grasses in the Currong by Robyn Whipp; and a technical note on long-stem planting from Marjo Patari. We hear from our "spy" at the Smithsonian, Zoë Smith, and as always, don't miss the research roundup, conferences and workshops, book reviews and more.

Letting nature take its course

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Our exploitation of the earth's resources inevitably comes at a cost to the environment in which those resources are situated or processed. When the scale of operations was small the disturbance to the environment was not a major concern. The industrial revolution brought a change in scale and geographical extent of disturbance as industrial conurbations were developed, and the raw materials to feed industrial demand came from the around the world. Some limited measures to control air and water pollution were introduced in the late nineteenth century but for the most part widespread environmental damage was accepted as the inevitable price of progress. This view prevailed until the 1960s when restoration of derelict sites became a major priority.

The first steps in the remediation of these brown field sites was to make them safe and to remove or contain contaminants. Urban sites were often redeveloped for housing or cleaner industries, sporting facilities (a common objective for former waste fill sites, both internationally and in Australia), or open space parklands; for rural sites conversion to productive agricultural lands was frequent. Only rarely were outcomes favourable to nature conservation the primary, or even secondary, objective.

In the west much of the historic legacy has now been addressed, but that is still far from the case in parts of eastern Europe and the former USSR, and in the developing world.

While new factories have to satisfy increasingly strict pollution controls from the outset, resource extraction continues apace, with modern mines being developed to a scale previously unimaginable. However, in most of the world rehabilitation of mine sites is no longer something which might be thought about at the end of a mine's life, but is a matter to be addressed during the approval process, and both the objectives of restoration and aspects of the processes to achieve these objectives may be specified by the permission granting authorities.

Increasingly the objectives include re-establishment of 'natural' vegetation cover and conservation of biodiversity which is required for one or both of two reasons – increasing the natural value of the sites and reinstating ecosystem functions and services, which could include productivity, protection of hydrological regimes or protection of the land surface against erosion (see Hobbs and Norton 1996). While maintenance of ecosystem functions and services is one of the prime justifications for biodiversity conservation, it is difficult with present knowledge to set quantitative targets for restoration projects. Goals will frequently be aspirational rather than closely defined, but increasing natural values may relate to components of biodiversity (such as individual rare species) which can be addressed through specified conditions.

Where the site to be restored contains extensive areas of bare substrate, as is the case with quarries and open cut mines, or some of the extensive coastal wetland rehabilitation projects in the northern hemisphere, there has been a dichotomy of approach between the use of technical measures (which involve planting) and reliance on spontaneous succession, (Prach and Hobbs 2008), although the division is not absolute, but rather there is a continuum.

Taking a historical perspective it is clear that 'natural' successional processes have lead to the creation of sites which are now regarded as being of high, and in some cases, exceptional, conservation value. For example the Broadland region of East Anglia in the UK developed by the recolonisation of Medieval peat mines (George 1992), and across Europe there are numerous flooded gravel pits, many of which provide venues for a range of aquatic recreational pursuits, which also support species and communities of conservation interest (Řehounková and Prach 2008).

However, over the last few decades technical restoration has been the predominant approach. There may be several reasons for this, but a major one is that consent and regulatory authorities like certainty, and specifying an end point to restoration to be achieved by planting and other measures is, if successful, a way of satisfying this need. Additionally technical restoration provides employment for consultants, nurseries and field staff.

Nevertheless, there is increasing evidence that in some circumstances spontaneous succession may be successful in achieving restoration goals and has the advantage of being low cost (Prach and Hobbs 2008). Tropek *et al.* (2010) have recently shown that in limestone quarries in the Czech Republic sites subject to technical restoration did not differ in species richness from those that had undergone spontaneous succession, but that the latter sites had more rare species, both plants and arthropods. The study is notable not only for its finding but also because it included assessment of habitat value for arthropods – while objectives often include provision of habitat for fauna, success is rarely measured.

Allowing regeneration to occur by spontaneous succession does not rule out the need for intervention. Some weeds, particularly woody weeds, and feral animals may need to be controlled (Řehounková and Prach 2008). Grazing regimes may be managed, and particularly in the Australian context, fire management may be necessary.

Relying on spontaneous succession will not be appropriate in all circumstances. Some sites may require extensive remediation before any growth is possible, for example, landfill sites (Gray 2010). The likelihood of desirable propagules dispersing to, and establishing in, sites will be influenced by the size of the site, the nature of the matrix in which the site is set (i.e., surrounded by natural/seminatural vegetation or in an agricultural or urban context). In other cases the biodiversity benefit objectives may be so specific that considerable intervention is required.

In Australia the area of mine and quarry sites available for restoration at the end of its working life will be considerable. Spontaneous succession may often be an appropriate approach to regeneration, but it will be important that all sites, whether subject to technical restoration or spontaneous succession, be appropriately monitored, and that the objectives and desired end points be defined so that the success of different approaches can be determined. Clear setting of objectives and implementation of monitoring has frequently not occurred, or monitoring has been poorly planned and executed. To have any value it is also necessary for the findings of monitoring to be fed back into the management regime. Ideally adaptive management should be practised, although consent authorities and proponents are reluctant to engage the concept because of fears of uncertainty and potentially open-ended financial commitments.

The public who make submissions to consent authorities may also be reluctant to embrace spontaneous succession because of uncertainty about success, and because it is perceived as being a lesser cost to developers.

Technical restoration will continue to have a large possibly major role in restoration but there needs to be greater recognition of the potential role of spontaneous succession, and increased public reporting of the outcomes of both technical restoration and spontaneous succession so that better informed decisions can be made. We can draw on the long history of ecological investigation into natural succession, but academic ecology should also seize the opportunity that restoration sites afford to carry out both observational and manipulative studies at spatial and temporal scales which are increasingly difficult to conduct in the wild (Young *et al.* 2005).

References

George, M. (1992). *The land use, ecology and conservation of Broadland.* Packard Publishing Limited, Chichester.

Gray, L. (2010). The RSPB's rubbish-dump revolution. *The Telegraph.* UK. 988: 26.

Hobbs, R. J. and D. A. Norton (1996). Towards a conceptual framework for restoration ecology. *Restoration Ecology* 4: 93-110.

Prach, K. and R. J. Hobbs (2008). Spontaneous succession versus technical reclamation in the restoration of disturbed sites. *Restoration Ecology* 16: 363-366.

Řehounková, K. and K. Prach (2008). Spontaneous vegetation succession in gravel-sand pits: A potential for restoration. *Restoration Ecology* 16: 305-312.

Tropek, R., Kadlec, T., Karesova, P., Spitzer, L., Kocarek, P., Malenovsky, I., Banar, P., Tuf, I.H., Hejda, M. and M. Konvicka (2010). Spontaneous succession in limestone quarries as an effective restoration tool for endangered arthropods and plants. *Journal of Applied Ecology* 47: 139-147.

Young, T.P., Petersen, D.A., and J.J. Clary (2005). The ecology of restoration: historical links, emerging issues and unexplored realms. *Ecology Letters* 8: 662-673.

Managing regrowth in Australia's changing rural landscape: a social phenomenon

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Much of the attention given to native plant regrowth in Australia has been in semi-arid rangelands in western NSW and Queensland. As noted by other articles in this volume, management of regeneration of native woody plant species (i.e. "regrowth") in these regions can have considerable impacts on agricultural opportunities, as well as landscape functionality and biodiversity conservation. But woody plant regeneration also occurs in many agricultural regions in south-eastern Australia. In particular, regrowth is becoming increasingly abundant in regions experiencing rapid changes in landuse demographics, such as agricultural areas close to regional cities and towns.

The extent of these regions is not trifling. Barr (2005) classified most of central, north-eastern and parts of eastern Victoria as a "rural amenity landscape" zone, in which traditional agriculture was being actively replaced by rural lifestyle development; other areas of the state were in "transition" towards this "amenity landscape" stage. Similar demographic changes are occurring in many regions of NSW and the ACT. In Victoria, many of these regions have witnessed extensive regeneration by a wide variety of native trees and shrubs (Lunt *et al.* 2010a), including many eucalypts and shrubs such as Burgan (*Kunzea ericoides;* Fig. 1) and Drooping Cassinia (*Cassinia arcuata*; Fig. 2). Coast Tea-tree (*Leptospermum laevigatum*) and Coast Wattle (*Acacia sophorae*) are responding in similar ways in coastal areas (e.g. Costello *et al.* 2000; Geddes 2009). It's possible that a complex socio-ecological dynamic exists in these regions. Initial landuse changes appear to encourage regrowth, and while the drivers that attract amenity landscape owners to a region are complex and not fully understood, it is possible that this regrowth attracts amenity landscape owners. These new land managers then change landuse further, in turn encouraging more regrowth, either intentionally or unintentionally.

Some people in these communities appear to value this regrowth quite highly, seeing it as "healing the scars" of earlier land use. However not everyone views regrowth this rosily, as one person's "precious regeneration" is another's "woody weed". For adjacent farmers implementing more traditional farm practices, regrowth may be seen as the very essence of "poor management". For example at a recent workshop, an extension officer told of new landholders enjoying their beautiful block of burgan-dominated "natural bush", until accosted by a neighbour for not controlling their "@#$% weeds". Agency staff added to the landholders' confusion by stating that, even though it wasn't "natural", they were unlikely to get permission to clear it. However, the same agency representative acknowledged great uncertainty about the conservation values of this (and other) types of regrowth. What is its value for biodiversity conservation? How does it contribute to catchment targets? Does it get "more natural" as it gets older? Should they encourage landholders to try to "improve" patches of regrowth? If so, how, and what should they aim to achieve?

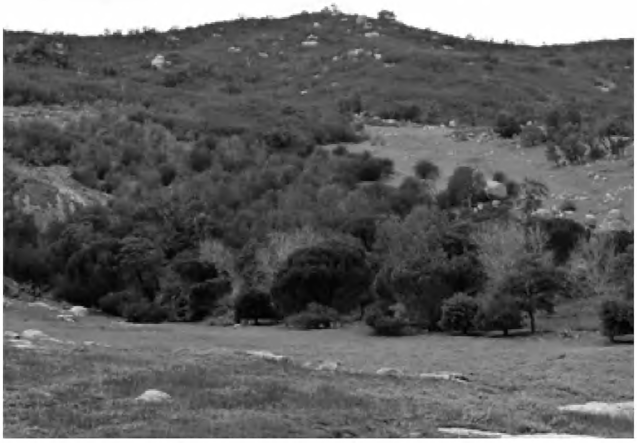

*Figure 1. Dense regeneration of Burgan (*Kunzea ericoides*) dominates this granitic ridgeline in central Victoria. Aerial photographs show this area had little woody cover in the 1940s. Photo: Ian Lunt*

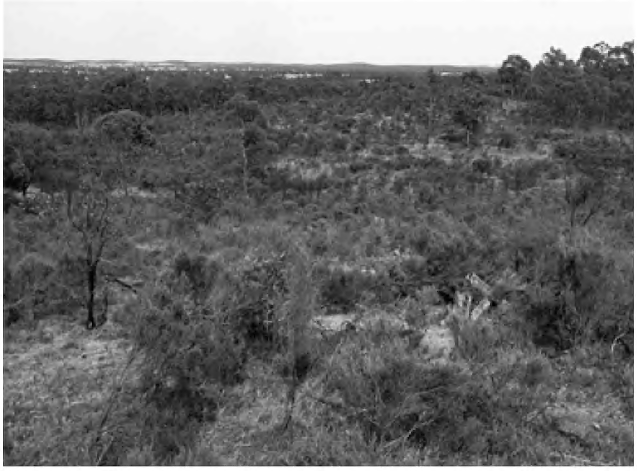

*Figure 2. Regrowth of Drooping Cassinia (*Cassinia arcuata*) and Grey Box (*Eucalyptus microcarpa*) following landuse change in central Victoria. Photo: Ian Lunt*

Unfortunately, there is little research to document how regrowth influences biodiversity patterns in many regions. Potential biodiversity values are likely to occur at the patch scale (through habitat provision) and the landscape scale (by enhancing cover and connectivity among other remnants). However, dense areas of regrowth may have detrimental effects on understorey plant diversity in some places (e.g. Costello *et al.* 2000). Importantly, many areas of regrowth may represent "novel ecosystems" (as described by Hobbs *et al.* 2009), which are maintained or influenced by human actions, and are unlikely to ever resemble the diverse "natural" ecosystems from which they were originally derived.

Of course, vegetation is valued for social as well as biophysical reasons. The concept of "ecosystem services", i.e. "the benefits people obtain from ecosystems" (Millennium Ecosystem Assessment 2005) may provide a useful framework to integrate the social and ecological values of regrowth, as may the complementary concept of ecosystem assets. Regrowth can provide a wide range of ecosystem services and "disservices" to communities, and these services may impact at scales from local (e.g. soil protection) to global (e.g. carbon sequestration). A short list of relevant ecosystem services includes landscape aesthetics, catchment hydrology, livestock health, biodiversity conservation, soil amelioration, fodder provision, carbon sequestration, rural amenity, spirituality, fire fuel loads, rural land property values, salinity control, recreational opportunities and erosion protection. Many readers may know of other topical issues. Importantly, however, few studies from Australian agricultural regions (out of the rangelands) have attempted to determine which ecosystem services or assets associated with regrowth are valued by regional communities, and whether communities assign different values to particular types of regrowth.

If we wish to maintain or enhance the ecosystem services that regrowth can provide, we will need to actively engage with communities to understand the social-economic drivers of present land-use decisions, how these communities perceive and value regrowth, and how this will affect their landuse options and decisions, and future biodiversity patterns.

To this end, we recently initiated a new research program with the (very long) title of "ecological and social responses to native plant regeneration in dynamic rural landscapes" <http://www.csu.edu.au/research/ilws/research/SRAs/SRA_regeneration.htm>. This multi-disciplinary research program aims to enhance environmental sustainability in rural Australia by improving our ability to manage regrowth for a broad range of social and environmental values. Occurrences of native regrowth provide an enormous opportunity to achieve many of our desired regional conservation goals, and protection of vital ecosystem services in agricultural regions - at very low cost. However it also presents a threat to viable landuses in some areas. *To manage regrowth well, we need a much better handle on what it delivers, what trade-offs exist, and how these are perceived and valued by different members of the community.*

References

Barr, N. (2005). *Understanding Rural Victoria.* Department of Primary Industries, Victoria, Melbourne.

Costello, D.A., Lunt, I.D. and Williams, J.E. (2000) Effects of invasion by the indigenous shrub *Acacia sophorae* on plant composition of coastal grasslands in south-eastern Australia. *Biological Conservation* 96, 113-121.

Geddes, L.S. (2009) *Plant community changes associated with Leptospermum laevigatum invasion and senescence on the Yanakie Isthmus, Wilsons Promontory.* Honours thesis. School of Botany, La Trobe University, Bundoora Melbourne.

Hobbs, R.J., Higgs, E. and Harris, J.A. (2009). Novel ecosystems: implications for conservation and restoration. *Trends in Ecology & Evolution* 24, 599-605.

Lunt, I.D., Winsemius, L.M., McDonald, S.P., Morgan, J.W. and Dehaan, R.L. (2010). How widespread is woody plant encroachment in temperate Australia? Changes in woody vegetation cover in lowland woodland and coastal ecosystems in Victoria from 1989 to 2005. *Journal of Biogeography* 37, 722-732.

Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC. <http://www.millenniumassessment.org/documents/document.354.aspx.pdf> (accessed 16 July 2010).

Protecting regrowth vegetation in Queensland: a case study in sustainable land management

Ben Lawson et al.

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Queensland's vegetation management framework regulates the clearing of native vegetation. It protects the State's biodiversity and, by conserving native vegetation, addresses land degradation problems such as salinity, soil degradation, erosion and declining water quality.

In the framework, the *Vegetation Management Act 1999* regulates the clearing of native vegetation made assessable under the *Sustainable Planning Act 2009*. The framework contains assessment codes and policies, exemptions from requiring clearing approval, prohibitions on clearing and enforcement provisions. Queensland's vegetation management laws allow for certain clearing activities to continue while ensuring these activities are done in a way that minimises their environmental impact.

The State's vegetation management framework is based on mapping of regional ecosystems. These are vegetation communities that are consistently associated with a particular combination of geology, land form and soil in a bioregion (Sattler and Williams 1999), with a total of 1375 regional ecosystems currently identified state-wide. Each regional ecosystem is assigned a conservation status of either Endangered, Of Concern or Least Concern according to the current extent of the regional ecosystem type relative to its estimated original extent. Areas of 'remnant' and 'regulated regrowth' regional ecosystems have been mapped and the maps are integral to the operation of the framework.

A combination of vegetation mapping, land tenure and clearing purpose interact to determine if approval is required to clear and if so, how and where vegetation clearing can be undertaken.

A short history of vegetation management in Queensland

Prior to 2000, vegetation clearing was only regulated on State land tenures, under the *Land Act 1994*. In 2000, the Queensland government enacted the *Vegetation Management Act 1999* to regulate clearing on freehold land. In 2004, the Government transferred the tree clearing provisions under the *Land Act 1994* to the *Vegetation Management Act 1999* so that all clearing was regulated under one Act. In addition, the Government moved to phase out broadscale clearing of remnant vegetation by 31 December 2006 with the provision of a $150 million financial assistance package for rural landholders and contractors. The Queensland Government's *Vegetation Management Act 1999* has successfully ended broadscale clearing across the state and now protects around 80 million hectares of woody ecosystems from loss of biodiversity and land degradation resulting from inappropriate clearing.

The imperative for regrowth conservation

The Statewide Land Cover and Trees Study (SLATS) which monitors changes in vegetation cover subsequently showed in its report released in February 2009 that, while there was an overall decrease in clearing rates, over 100,000 hectares of regrowth was cleared in the 2006-2007 reporting period. In response to this in April 2009, the Queensland Government introduced a six month moratorium on clearing of endangered regrowth vegetation and riparian areas of priority Great Barrier Reef river catchments. During the moratorium, the Queensland Government consulted with stakeholders on workable long-term regrowth protection measures.

The moratorium was replaced by new regrowth laws on 8 October 2009 which provide for the long term regulation of regrowth vegetation on agricultural and grazing leasehold land and non-urban freehold and indigenous land through a performance based compliance code. The laws apply to all native woody regrowth within 50 metres of mapped watercourses in the priority Great Barrier Reef Catchments, and mapped high value regrowth.

These areas of regulated regrowth vegetation are shown on a regrowth vegetation map, which is available for download free of charge (along with remnant regional ecosystem maps) from the Queensland Department of Environment and Resource Management (the department) website <http://www.derm.qld.gov.au>.

Mapping regrowth vegetation across Queensland

High value regrowth

The new regrowth protections apply to the clearing of mapped regrowth vegetation across the State to protect regrowth that is Endangered, Of Concern and Least Concern if the area has not been cleared since 1990.

The regrowth mapping was developed using satellite imagery, pre-clearing regional ecosystem data and Foliage Projective Cover (FPC) data. The regrowth mapping was designed to capture woody vegetation that is of forest quality (a minimum of 11 per cent FPC), has not been re-cleared since 31 December 1989 (i.e. at least 20 years old) and is either an Endangered, Of Concern or Least Concernregional ecosystem. The 20 year age filter targets areas that are most likely to be functioning regional ecosystems, while avoiding productive rural lands that are rotationally cleared. This vegetation age also aligns with the national carbon accounting system and the Kyoto Protocol dates.

Different levels of regulatory protection exist for each different conservation status of regrowth regional ecosystems. For example, Endangered vegetation (with less than 10 per cent of each endangered regional ecosystem remaining across the landscape in its mature form) is afforded the most protection in recognition that it has been the most affected by past broad-scale clearing practices. In contrast, the clearing of Least Concern regrowth is allowed except where located in riparian areas, in or around wetlands, in areas identified as essential regrowth habitat for threatened species, and on steep slopes where it guards against land degradation.

The careful targeting of these measures based on the conservation status of the regional ecosystem maximises the protection of biodiversity, landscape processes and the recovery of endangered ecosystems, while minimising the effects on productive rural lands and rural enterprises.

Regrowth watercourses

All native regrowth vegetation within 50 metres of a regrowth watercourse is regulated in the priority Great Barrier Reef catchments of Burdekin, Mackay Whitsunday and Wet Tropics. There is no age threshold on this vegetation as the primary objective of retaining this vegetation is to reduce the run-off to the Great Barrier Reef by intercepting run-off of nutrients and pollutants before they enter the waterway, and by stabilising stream banks.

Regrowth watercourses are identified from 1:100 000 scale stream-ordered watercourse mapping for the priority catchments, with clearing requirements based on the stream order of each section of watercourse. For example, larger buffers from clearing are required for higher order streams.

An innovative policy approach to regulating regrowth vegetation

The clearing of regulated regrowth vegetation is regulated by the regrowth vegetation code (the code). The code applies to clearing regulated regrowth vegetation unless the clearing can be undertaken under an exemption in the vegetation management framework.

Landholders wanting to clear regulated regrowth vegetation must follow the specific requirements set out in the code. The code sets out how clearing can be done, including ensuring the protection of sensitive parts of the landscape such as wetlands, watercourses, essential habitat for protected species and steep slopes.

Landholders do not need a permit to clear regrowth but are required to notify the department of their intention to clear before they start any clearing. This allows the department to actively monitor compliance with the code and to review its effectiveness.

This approach recognises the current sustainable practices of the majority of landholders and was developed in close consultation with rural industry groups.

Working with landholders

A key component of these regrowth protections is active and ongoing engagement with landholders to assist them to understand their responsibilities for vegetation management and allow continued economic activity.

To achieve this, the new regrowth code is supported by a plain language *Landholders' guide to the regrowth vegetation code* explaining how landholders can apply the code 'on ground'. In addition, $2 million has been made available to deliver an industry assistance program. Queensland Farmers' Federation and AgForward, a company established by AgForce, will partner with the Government to assist landholders by providing expert technical advice, facilitating workshops, and holding practical field days to give 'on ground' explanations and demonstrations of activities under the code.

Conclusions

Queensland's recently implemented regrowth protections recognise the important role of native regrowth vegetation in the landscape and provide continued opportunity for sustainable rural production. In consultation with both conservation and rural industry groups, an innovative regulatory approach was implemented that allows landholders to sustainably manage vegetation on their properties, while also protecting more than one million hectares of regrowth vegetation with important biodiversity and environmental values.

References

Sattler, P. S. and Williams, R. D. (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Conservation and the mulgalands of eastern Australia: an unusual case of regrowth

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Introduction

We outline the key biodiversity conservation issues for the mulgalands of eastern Australia in a contemporary context. The mulgalands are unique because 'regrowth' is not the key to conservation. The biodiversity challenges of the mulgalands are centrally concerned with the restoration of the highly degraded herbaceous component of the vegetation. This can only be achieved with a policy, utilising incentives and active ecosystem management.

Why the mulgalands are unique

Much of terrestrial conservation efforts in Australia focuses on conserving biological diversity and ecological processes in 'fragmented' agricultural landscapes. This is particularly true in a broad arc stretching from south-western Western Australia, to the east and central parts of Queensland where extensive land clearing has occurred with considerable biodiversity impacts. Although the era of broad scale clearing is ending, policy, regulations and conservation efforts remain focused on 'regrowth' and improving the 'connectivity' of remnant and regrowth vegetation in these landscapes.

The mulgalands[1] of eastern Australia are to the north and west of the agricultural development arc. They have suffered considerable degradation from historic total grazing pressure by domestic, feral and native herbivores. This has been aggravated by the dominant Mulga (*Acacia aneura*) being an important source of feed for cattle and sheep. For over 100 years graziers have utilised Mulga as a source of feed by cutting it down to make it available for their stock. This practice has many names but is now generally known as 'fodder harvesting'. Over the years, methods of fodder harvesting have changed.

This practice is not considered as clearing by the landholder for two key reasons:

- regrowth from seed of Mulga is vigorous and anticipated; and
- Mulga regeneration is considered desirable as it then provides for fodder at a later date when conditions become dry again.

The distinction here between conventional land clearing and fodder harvesting is important to explore. Fodder harvesting requires considerable skill and experience to achieve an appropriate balance between too much Mulga regeneration and too little. Either too much or too little Mulga locks up herbaceous recovery, which is also influenced by rainfall patterns and grazing management. Grazing management and a mix of cattle and sheep results in a new 'crop' of Mulga somewhere between 10 and 20 years (Page *et al.* 2008). Consequently loss of Mulga is considered undesirable. An important confounding issue here is the variance in perceptions of what was, or should be, the 'natural' state of vegetation for the mulgalands.

Too many trees?

'Regrowth' and 'thickening' have been controversial topics (Beeton *et al.* 2005). The expressed historical narrative of vegetation changes is that the widespread introduction of sheep and cattle in the middle of the 19th century led to a dramatic collapse of ground cover and perennial grasses, which in concert with the removal of indigenous fire management resulted in a widespread increase in shrub and tree cover (i.e. thickening) (Witt *et al.* 2009). Thus, the increased woody component of the vegetation then suppressed opportunity for vigorous herbage growth and has locked the system into a new relatively stable state of woody dominance rather than the more open systems believed to be in place prior to the period between 1850 and

Typical dense Mulga stand resulting from regeneration following fodder harvesting several decades earlier. Photo: G.B. Witt, 2006

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[1] It should be noted that other plant associations occur in patches throughout the Mulgalands and are not subject to the arguments present here.

1900. The collapse of the semi-arid grazing systems was most pronounced at the time of the 'Federation drought' when sheep and cattle numbers were at historically high levels. This combined with the rapid spread of rabbits devastated the standing biomass.

This is the key conservation issue for the mulgalands. The decline in herbaceous ground cover due to grazing, removal of fire and competition with woody vegetation (in combination with the predation of cats and foxes) has most likely been the greatest contributor to the loss of biological diversity and ecological processes that maintain functionality, conserve nutrients and resources in the mulgalands. Loss of habitat through the clearing of woody vegetation is not a significant issue with the exception of some areas in the east and south-east of the region where a problem occurred during the late 1990s to early 2000s with the 'panic' and irrational clearing that preceded Queensland Government legislation to restrict clearing on freehold land.

The 'real' challenges for conservation in the mulgalands

For understandable reasons, 'regrowth' is usually implicitly considered desirable from a biodiversity point of view. In addition, it is frequently constrained to a discourse around trees. In the mulgalands of eastern Australia, it is not the regrowth of trees that is the central biodiversity conservation issue but rather the 'regrowth', or perhaps more accurately the restoration, of herbaceous cover and ecological function at the soil/herbaceous scale, that is paramount. Notwithstanding this, the current 'state' of the mulgalands is in all likelihood relatively stable (Witt *et al.* 2006) given climatic fluctuations. So it is a matter of choice for society if it desires to shift the mulgalands from a stable, yet probably undesirable biodiversity state to another state which is ecologically more responsive and resilient, with improved carbon content in the soil, and able to provide a greater range of biodiversity.

Restoring the 'natural' herbaceous layer through a policy framework that encourages and rewards land management geared to this end should be the challenge. It is also important to note that passive management (such as removal of domestic stock) on the assumption that the system will restore itself to some 'natural state' has been demonstrated to be ineffective. Removal of stock alone, with no active control of other grazing pressure, and with no active management of the vegetation, leaves these systems no better off than under a conservative grazing regime.

Policy to achieve better conservation outcomes for the mulgalands therefore should allow for a range of manipulative practices also including clearing, managing total grazing pressure, and the use of fire to keep an appropriate balance between woody and herbaceous vegetation (Beeton *el al*. 2005). This is in contrast to the focus to date which has tended to be on the restriction of activities, rather than the facilitation of desirable outcomes in culturally modified landscapes.

Perhaps we need to broaden the discourse of 'regrowth'—which it could be argued is a very southern Australian centric issue—to 'restoration', to avoid the preoccupation with trees as a surrogate for biodiversity.

References

Beeton, R.J.S., Slaughter, G., Page, M. and Greenfield, R. (2005). Study of Fodder Harvesting in the Queensland Mulga Region Ecosystems. Report to DNRMW Queensland.

Page, M.J, Witt, G.B., Noël, M.V., Slaughter, G. and Beeton, R.J.S. (2008). *Economic and environmental analysis of fodder harvesting practices associated with mulga (*Acacia aneura*) and fire management practices in the mulgalands of south western Queensland.* Final Report to Australian Government, Department of the Environment, Water, Heritage and the Arts. (School of Natural and Rural Systems Management, The University of Queensland, Australia).

Witt, G.B., Harrington, R.,A. and Page, M.J. (2009). Is 'vegetation thickening' occurring in Queensland's mulgalands? — a 50-year aerial photographic analysis. *Australian Journal of Botany* 57: 572–82.

Witt, G.B., Luly, J. and Fairfax, R.J. (2006). How the west was once: vegetation change in south west Queensland ~ 1930–1995. *Journal of Biogeography* 33, 1585-96.

Mulga harvested for fodder in the dry period between 2001 and 2005. Photo: M.V. Noël, 2008

Regrowth in south-western Australia: challenges and opportunities

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The mallee belt of south-western Australia was rapidly cleared and developed for agriculture from the 1890s. Much of the region remains under wheat and sheep today but there has been increasing interest in planting native trees for salinity control, wood products and more recently, carbon sequestration. It seems likely that farms of the future will contain a mix of enterprises that includes native vegetation and the ecosystem services it provides alongside the more traditional farming practices (Fig. 1). In such a model, native vegetation is a valued asset and therefore its regrowth would be encouraged. Unfortunately, there are several barriers to the regrowth of native woody vegetation after abandonment of agriculture in south-western Australia. I will discuss each of these in turn and conclude each section with some ideas to help overcome these barriers.

Agricultural disturbance favours seeders over resprouters

There is a trade-off between persistence and colonization among woody plants in fire-prone ecosystems. Woody plants that resprout after fire can persist at a site for hundreds to thousands of years. These plants invest in belowground structures at the expense of seeds and seedlings. In contrast, the strategy of woody plants that are killed by fire is to regenerate from seeds and consequently these plants (seeders) tend to produce more seeds and more vigorous seedlings than resprouters. While both strategies operate in intact landscapes subject to wildfire, seeders have a distinct advantage over resprouters in the recolonisation of land that has been cleared of native vegetation.

My colleagues and I have observed patterns consistent with this prediction in the heavily cleared agricultural landscape of south-western Australia. Resprouters were poorly represented among the woody plants that recolonised abandoned farmland (old-fields) compared with seeders. Further we found that seeders with hard seed coats and a persistent soil seed bank (e.g. *Acacia* spp.) were more likely to recolonise old-fields compared with species that did not maintain a soil seed bank (Standish *et al.* 2007). Armed with this knowledge, management intervention might focus on increasing the seed supply of species that do not maintain a soil seed bank with particular attention given to the resprouters, given that they produce few seeds compared with seeders. Increasing seed supplies via seed orchards will become increasingly important as revegetation efforts increase into the future.

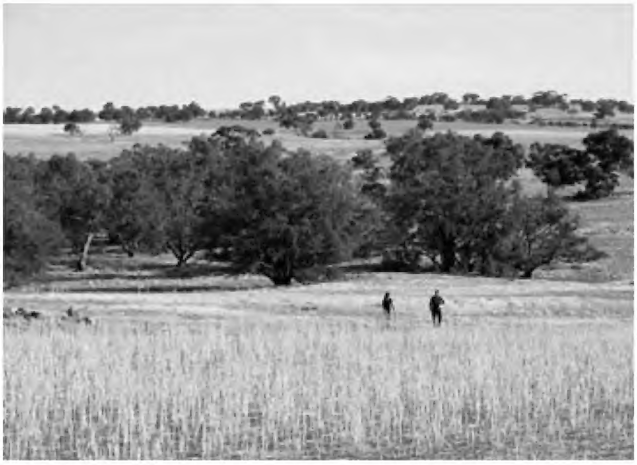

Figure 1. UWA Future Farm near Pingelly in Western Australia's wheatbelt. This site has been set aside for native trees, shrubs and understorey species. The vision for the farm is to account for ecological values alongside production values to create a best-practice farm by 2050. Photo: Richard Hobbs.

Growing species with episodic recruitment

Episodic or event-driven recruitment is common among long-lived woody seeders. Species such as mallee eucalypts that live for hundreds of years might recruit once every 20 years as a result of the rare coincidence of fire and favourable conditions for seedling establishment (Wellington & Noble 1985). Again, while this strategy has evolved under natural conditions, it is not optimal for old-field recolonisation unless we are prepared to wait (and assuming seed sources are nearby). Fortunately it is possible to intervene so as to affect recruitment in shorter timeframes, at least for species for which germination cues are known. Then seedling establishment of most woody species can be improved with water addition through the first summer drought and, in some cases, nutrient addition.

Nutrient-enriched old-fields: help or hinder regrowth?

Old-fields are often nutrient enriched from years of superphosphate-fertiliser application which can potentially differently affect the establishment of native species. Research and field observations suggest that species capable of rapid growth such as members of the *Acacia* and Eucalypt genera are likely to be P-responsive and therefore benefit from nutrient enrichment. Invasive species may also benefit from nutrient enrichment (see below). In contrast there will be other species that are likely to be P-sensitive including the proteaceous species (e.g. *Hakea* spp.) which may not benefit from nutrient enrichment.

There are other possible effects of elevated nutrients from chemical fertilisers. Research elsewhere in the world suggests a negative effect of elevated chemical fertility on soil biological fertility. Biological fertility encompasses the diversity of soil biota that drive ecosystem processes such as leaf litter decomposition and nutrient cycling. Chemical fertility can also alter the symbiosis between plants and mycorrhizal fungi such that the fungi become parasitic rather than beneficial to their plant hosts under elevated nutrients. The consequences of elevated nutrients for regrowth of native vegetation on old-fields in south-western Australia is not well understood, but it could mean that soil microbes and fungi are low in abundance or not functioning as they usually would in native vegetation and this may have repercussions for plant establishment and persistence.

Persistent exotic species

Invasion by exotic species can significantly limit the establishment of native species on old-fields (Standish *et al.* 2008). In our experience degraded sites affected by persistent invasive exotic species are typical of those sites set aside for native vegetation. The good news is that once established native species appear to be able to out-compete the common agricultural weeds. One of the old-field properties within the visionary Gondwana Link project <http://www.gondwanalink.org/> was dominated by agricultural weeds before being restored to a landscape of green trees in less than a decade (Fig. 2).

Opportunities for regrowth

Last century was one of widespread land degradation for the wheatbelt of south-western Australia. I am optimistic that this century will be one of recovery and renewal whereby new farming enterprises will create better opportunities for the conservation of native species. This will require ongoing changes to agricultural practice, implemented through the development of economic, scientific, social and policy dimensions of the sector. Above all else agriculture relies on the continued provision of ecosystem services provided by the diversity of biological life within the landscape. This reality needs to be apparent in the way we choose to grow our food.

References

Standish, R.J., Cramer, V.A., Wild, S.L. and Hobbs, R.J. (2007). Seed dispersal and recruitment limitation are barriers to native recolonisation of old-fields in Western Australia. *Journal of Applied Ecology* 44:435–445.

Standish, R.J., Cramer, V.A. and Hobbs, R.J. (2008). Land-use legacy and the persistence of invasive *Avena barbata* on abandoned farmland. *Journal of Applied Ecology* 45:1576–1583.

Wellington, A.B. and Noble, I.R. (1985). Post-fire recruitment and mortality in a population of the mallee *Eucalyptus incrassata* in semi-arid, south-eastern Australia. *Journal of Ecology* 73: 645–656.

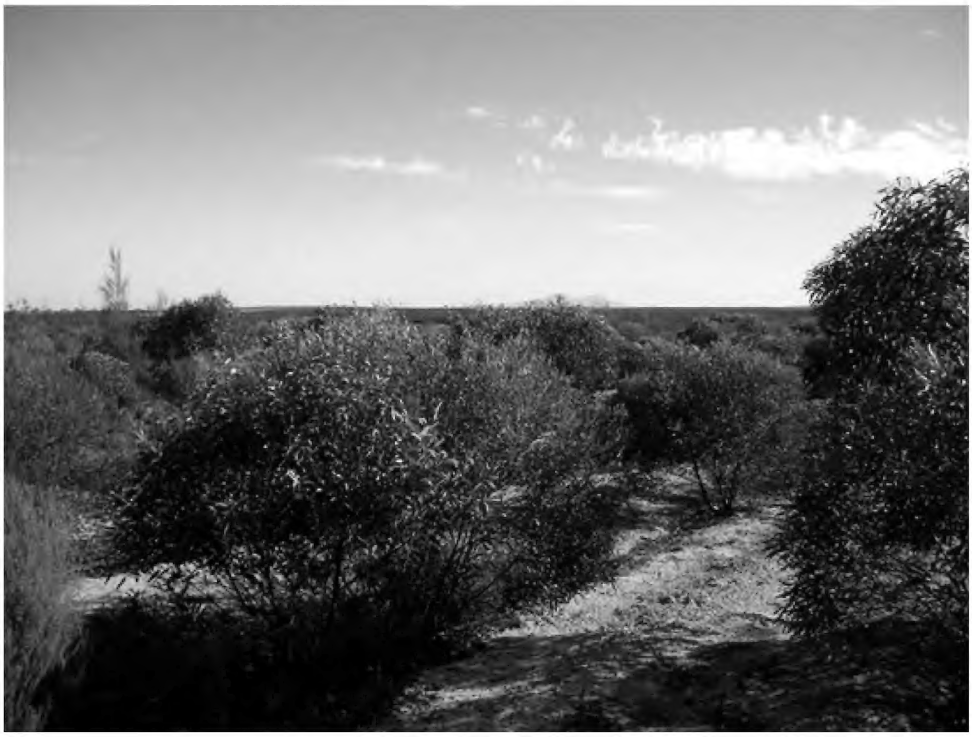

Figure 2. Restored vegetation at Chereninup, the first property to be purchased for the Gondwana Link project. This photo was taken in April 2010, seven years after weed control, seeding and planting. The Stirling Ranges are visible in the background. Photo: Michael Perring

Regrowth and conservation in New Guinea

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There are extensive areas of secondary regrowth in the Highlands of Papua New Guinea, ranging from coarse grass to cane grass to woodland. Regardless of their familiarity with, and detailed knowledge of regrowth vegetation, people of the Southern Highlands are strangely casual about the plants that colonise an abandoned garden site. They make little effort to manage such successions, in the sense of planting and/or encouraging certain species over others. According to them they have little control over the process, e.g. whether it is grasses or tree seedlings that colonise a site, or what species of grass or tree. Rather, they allow nature to take its course. Succession is largely influenced by seed supplies from surrounding vegetation, e.g. trees are more likely to colonise sites adjacent to forest and grasses are more likely in grassland.

The actions of gardeners may nonetheless influence the sequence of natural regeneration to some extent. The length of time for which they cultivate sites and the thoroughness with which they clear them of natural vegetation may affect the species composition of subsequent regeneration. If they coppice and pollard some trees, these may shoot again, ensuring that some of the site's original species recolonise it. Trees that commonly send up shoots again include *Lithocarpus, Ficus, Artocarpus,* among others. They may circumvent otherwise gradual succession sequences, resulting in a cover of mature trees far sooner than is usual. People may also influence the species composition of some abandoned sites by what they cultivate on them. They may plant some trees and shrubs that will remain when they abandon a garden. Among those which yield edible and usable products are the *Naep* Casuarina (*Casuarina oligodon*), *Aenk* Pandans (*Pandanus julianettii*) and *Aegop* Cordylines (*Cordyline fruticosa*), together with the occasional *Poiz* Fig (*Ficus wassa*) and *Shuwat* Fig tree (*Ficus dammaropsis*).

People are well aware of succession, as evident in their classification of various stages. Abandoned gardens go through a series of overlapping plant sequences that are botanically varied, with initially quickly changing communities. When initially abandoned, the species composition and abundance varies depending on environmental conditions, but in broad terms the same pattern repeats itself. At the time of abandonment certain rapidly growing pioneer grasses such as *Arthaxon, Paspalum, Ischaemum, Setaria* and *Isachne* and herbs, which include *Bidens pilosus, Adenostemma lavenia, Cynoglossum javanicum*, *Crassocephalum*, *Polygonum*, *Viola,* and *Rubus*, flourish at the expense of the few remaining crop plants. Some crops, such as Sweet Potato, Highland Pitpit (*Setaria*), bananas and Sugar Cane, compete successfully against invading weeds and remain for some time. This herbaceous regrowth stage may be followed by a succession of coarse grasses such as *Ischaemum* and *Imperata*, with *Leersia* swamp grass in wet depressions. The occasional tree seedling or juvenile cane grass clump may also occur. A site under *Ischaemum* may be brought back under cultivation after a period of grassy fallow, whereas *Imperata* marks a heavily disturbed site with fertility problems (e.g., thin topsoil, repeated burning, etc.). If natural regeneration proceeds, either Cane Grass or tree saplings, or a mixture of both, begin to grow. These first stages of regrowth support scant wildlife populations, largely small rodents and a few grass seed feeding bird visitors.

Early stage regrowth at Tomb (sweet potato mounds still visible under grass). Photo: Paul Sillitoe

The Cane or Sword Grass community is dominated by *Miscanthus*, which comprises robust two to three metre high culms and grows in dense clumps that produce a thick cover frequently impenetrable without a bush knife. However, the grass community is more open where species are less mature and more widely spaced, particularly near homesteads where the rooting activities of foraging pigs create patches of exposed earth. Sword grass regrowth predominates in the majority of valleys where people live and cultivate between l600 m and 2000 m, interspersed with current cultivations and grassy regrowth of recently abandoned gardens. It is second in extent only to montane forest, which it has gradually replaced as human population and anthropogenic activities have expanded. Repeated cultivation, occasional grass fires, and other disturbances contribute to the maintenance of such fallows following forest clearance, together with environmental factors responsible for seedling death, such as soil-plant nutrient imbalances and sub-optimal drainage conditions. Thick brakes of *Saezuwp* Fern (*Dicranopteris*) may occur among the cane and occasional clumps of Low Fern (Thelypteridaceae). Other cane grasses sometimes occur, including Job's Tears (*Coix*), brakes of Wild Sugar (*Saccharum*) and patches of Tall Grass (*Pennisetum*) on wooded margins. Scattered trees of cultivated Screw Pines (*Pandanus*), and the Graceful Tree Fern (Cyathaceae) are also common as succession progresses. Forests may eventually succeed cane grassland where left undisturbed for long enough. Cane grassland supports relatively meagre wildlife populations consisting primarily of small rodents and some birds, particularly in comparison with montane forest, which supports diverse wildlife including marsupials, rodents and birds, some of them eye-catching and large.

Secondary forest is the alternative long-term floristic succession to Cane Grass. When cleared garden plots in rainforest areas are abandoned they rapidly regenerate into patches of secondary forest. Tree regrowth also occurs in pockets throughout the Cane Grassland zone but has a markedly different floristic composition to montane forest and a considerably lower canopy at ten to twenty metres. Dominant species include fast growing soft-wooded trees primarily, such as various Spurges (Euphorbiaceae), Pipers (Piperaceae), Nettles (*Pipturus*), Figs (*Ficus*), Umbrella Trees (*Schefflera*), Dillenias (*Saurauia*), Silkwoods (*Cryptocarya*), Woolly Cedars (*Trema*) and Switchsorrels (*Dodonaea*), several of them attractive to feeding birds when fruiting. The *Henk* Tree Fern (Cyatheaceae) is also a common understory tree. Where Cane Grasses (*Miscanthus, Coix*) exceed a certain indeterminate number, the regrowth becomes more akin to Cane Grassland; there is no sharp distinction between these two vegetation communities. The ground cover is on the whole considerably less dense than primary forest, consisting of various coarse and creeping grasses and shrubs, sometimes growing to waist height. Ferns are also common, notably in sprays across the forest floor (Thelypteridaceae) and sometimes in tangles (*Pteridium* and *Dicranopteris*), together with tall leafy herbs, notably gingers (Zingiberaceae).

Cane grassland with pandan in foreground at Maip. Photo: Paul Sillitoe

Patch of secondary woodland at Ganonkiyba with primary forest on ridge. Photo: Paul Sillitoe

Regenerating forest patches in grasslands rarely develop into mature wooded stands because of clearing by land holders for gardens and repeated collection of firewood and raw materials. Nonetheless, if left undisturbed it is likely that montane forest would eventually establish itself. Humans also influence succession through the actions of domesticated animals, e.g. foraging pigs may damage garden cultivations so extensively that they are abandoned by landholders.

The location of secondary forest influences the diversity of wildlife it comprises. For example, when surrounded by montane forest supporting abundant wildlife, secondary forest fauna is are likewise plentiful, and when located in cane grassland where wildlife is limited, fauna is sparse; although tree fruits can attract birds in considerable numbers when ripe. Hunters frequently visit areas of secondary woodland within the forest that support fruiting vegetation, including *Saurauia*, *Trema*, *Maesa*, *Schefflera* and *Cryptocarya*, which attract animals such as cuscus, ringtails and giant rats. The influence that areas of disturbed vegetation have on animal populations, particularly ecotones (transition zones between different plant communities) is noteworthy. Human interference may lead to an increase in some animal populations, by creating vegetation communities and ecotones that yield shoots and fruits popular as food with some game. Some archaeologists suggest that humans in the past may have deliberately interfered with the vegetation in places, to promote mixed plant communities, whereas today this occurs as a by-product of swidden farming.

Fostering Brigalow regrowth for biodiversity conservation and carbon sequestration

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Introduction

Brigalow forests and woodlands are characterised by the presence of *Acacia harpophylla* in the canopy. Prior to European settlement these ecosystems occupied extensive areas of fertile clay soils in Central Queensland and Northern New South Wales. Since World War II however, most Brigalow stands have been converted to pasture or cropping and the small areas of remaining mature forest are now classified as endangered under Queensland and Federal legislation. Unlike most Australian Acacias, *A. harpophylla* rarely flowers and does not have a hard seed coat, but it is capable of prolific root suckering following clearing (Johnson 1964). Despite efforts to control *A. harpophylla* suckers, areas of regrowth remain and clearing of this regrowth is now regulated under Queensland legislation. Brigalow regrowth provides excellent restoration opportunities in over-cleared, fragmented parts of the landscape. Fostering Brigalow regrowth also presents a great opportunity to sequester carbon as suckers grow into forests. With these restoration and carbon benefits in mind, the overarching questions of our research were:

1. What are the long term effects of the agricultural legacy, in combination with environmental factors, on both the restoration and carbon potential of Brigalow regrowth?
2. Does restoration thinning accelerate forest restoration and carbon sequestration in dense Brigalow regrowth?

Methods

To answer the first question, a large regional survey of Brigalow regrowth was conducted throughout central Queensland in late 2007. Stand structure and environmental variables were measured and management history information was collected for each patch. Data was analysed in a two-step approach relating (i) management history to stem density and then (ii) relating stem density and environmental factors to the recovery of forest biomass and structure. A large thinning experiment was established in 2006 to address the second question. It was

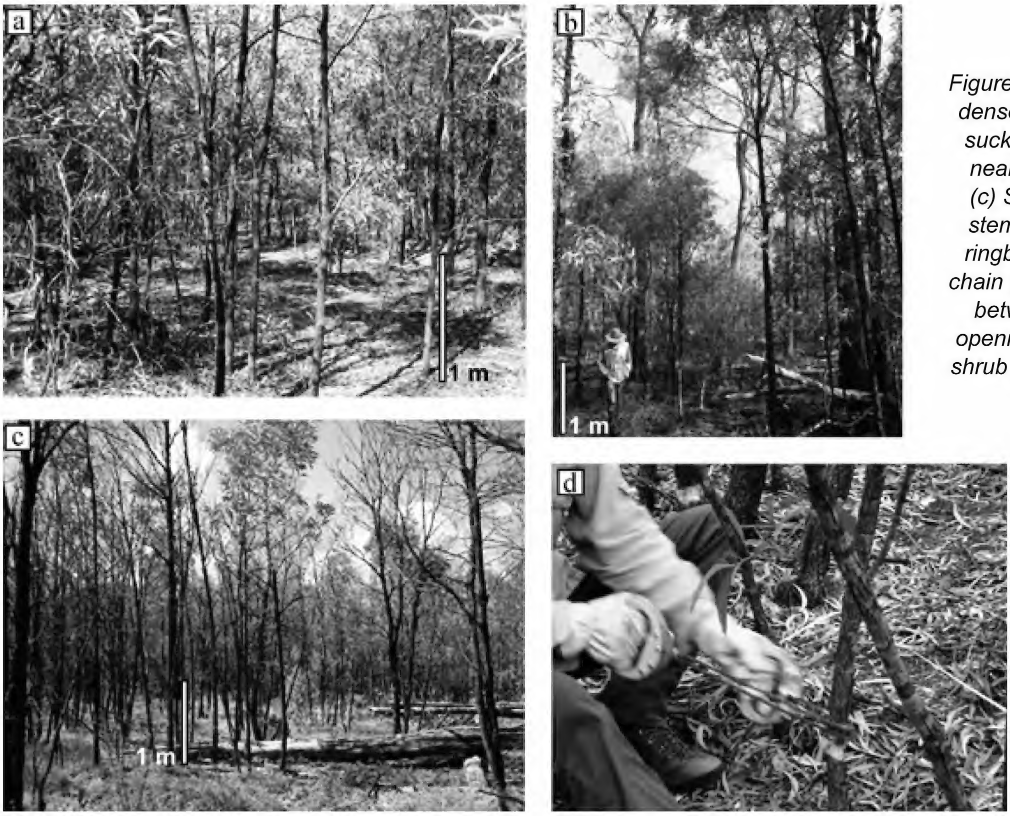

Figure 1. (a) A control plot showing dense 27 year old A. harpophylla suckers (17,000 stems ha^{-1}), (b) nearby mature Brigalow forest, (c) Severely thinned plot (1000 stems ha^{-1}) and (d) stems were ringbarked manually using saw-chain girdlers. Note the differences between (a) and (c) in canopy openness, ground vegetation and shrub growth. Photos: John Dwyer

located in 27 year regrowth in Bulli State Forest, southern Queensland. The average stem density before thinning was 17,000 stems ha^{-1} (Fig. 1a), compared to 2,500 stems ha^{-1} in a nearby mature Brigalow forest (Fig. 1b). Plots were either left as controls (not thinned) or thinned down to 1000, 2000 or 4000 stems ha^{-1} (Fig. 1c). Treated stems were manually ringbarked (Fig. 1d) when soil moisture was high to reduce the risk of secondary suckering (Johnson 1964). Growth and survival of 480 randomly selected stems was then monitored for two years. Statistical models were used to quantify the effects of thinning on stem growth and survival and finally a simulation model of forest growth was developed to predict forest recovery under different thinning regimes.

Results and Conclusions

Regional survey of Brigalow regrowth

Repeated attempts at clearing regrowth were associated with higher densities of suckers, and this effect was evident for at least 50 years following the last clearing attempt. Subsequently, higher density stands were slower to develop mature forest structure and biomass. Annual rainfall had a positive effect on the rates of biomass accumulation and structural development. The central and eastern parts of the study region are most climatically and geologically suitable for rapid biomass accumulation, however these may not correspond to the areas that historically supported the highest biomass Brigalow forests.

Experimental thinning trial

Thinning increased the growth rate and survival of remaining stems and also increased the density and diversity of other native plant species. Severe thinning (i.e. down to ≤ 2000 stems ha^{-1}) increased canopy openness which in turn promoted native grass and forb growth (Figure 1c). It is important to note that Brigalow ecosystems are generally fire sensitive and management should aim to maintain grass cover at low levels. This is particularly important in central and northern parts of the Brigalow landscape where invasion by flammable pasture grasses (primarily buffel grass), poses a huge fire risk to remaining forest remnants. Model simulations indicated that the optimal thinning treatment for restoration and carbon sequestration was 6000 stems ha^{-1} in this type of dense regrowth. Stands thinned to this density were predicted to attain mature structure decades sooner than unthinned stands, while maintaining canopy cover at high enough levels to prevent grass proliferation.

The thinning method adopted in this study was ideal in an experimental setting, but is unlikely to be adopted at the regional scale. Further research is required to identify a more efficient method that still delivers the ‘natural’ stem arrangements required for restoration.

Implications for plant conservation in the Brigalow Belt

Brigalow ecosystems provide habitat for at least sixteen threatened plant species (Bean 2004, Butler 2008). Many of these are *Solanum* spp. (all in subg. *Leptostemonum*) including three species which have been recorded mainly in Brigalow forests or Brigalow regrowth (Bean 2004). Given the paucity of large, intact Brigalow forest remnants, regrowth is almost certainly contributing to the persistence of many plant species in this recently modified landscape. Regrowth will become increasingly important as the longer term impacts of broadscale clearing play out and also as the climate continues to warm and dry as predicted. *Acacia harpophylla* exhibits considerable resilience to severe disturbances and has a broad climatic tolerance (Johnson 1964). The capacity for other plant and animal species to re-assemble around *A. harpophylla’s* robust framework while adapting to ongoing environmental change will depend on (i) the ecology of the species, (ii) the management of exotic species and fire, (iii) the spatial arrangement and connectivity of the Brigalow ecosystem network and (iv) the context of this network in the broader landscape. Importantly, restoration in the Brigalow landscape will be most successful if fostering regrowth becomes an economically viable land-use option that can be integrated with established agricultural practices. The emerging carbon economy may allow this to becoming a reality.

Note

This article is a summary of recent PhD research undertaken at the University of Queensland under the supervision of Dr Yvonne Buckley and Dr Rod Fensham and with research funding from the Fitzroy Basin Association Inc. and CSIRO. Refer to Dwyer *et al.* (2009), Dwyer *et al.* (2010a) and Dwyer *et al.* (2010b) for more information.

References

Bean, A.R. (2004) The taxonomy and ecology of *Solanum* subg. *Leptostemonum* (Dunal) Bitter (Solanaceae) in Queensland and far north-eastern New South Wales. *Austrobaileya* 6:639-816.

Butler, D.W. (2008) *Draft Recovery Plan for the “Brigalow (*Acacia harpophylla *Dominant and Co-dominant)” Endangered Ecological Community*. Report to Department of the Environment, Water, Heritage and the Arts, Canberra. Environmental Protection Agency, Brisbane.

Dwyer, J.M., Fensham, R.J., Butler, D.W. and Buckley, Y.M. (2009) Carbon for conservation: assessing the potential for win-win investment in an extensive Australian regrowth ecosystem. *Agriculture Ecosystems & Environment* 134:1-7.

Dwyer, J.M., Fensham, R.J. and Buckley, Y.M. (2010a) Restoration thinning accelerates structural development and carbon sequestration in an endangered Australian ecosystem. *Journal of Applied Ecology* 47:681–691.

Dwyer, J.M., Fensham, R.J. and Buckley, Y.M. (2010b) Agricultural legacy, climate and soil influence the restoration and carbon potential of woody regrowth in Australia. *Ecological Applications*, *in press* (accepted 09/01/2010).

Johnson, R.W. (1964) *Ecology and Control of Brigalow in Queensland.* Queensland Department of Primary Industries, Brisbane.

Greening Australia's position on accounting for carbon in sinks broadly classified as 'regrowth'

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This position statement focuses on the value of natural, native regrowth from the perspective of carbon sequestration. As a general rule, Greening Australia takes into account biodiversity factors in it approach to restoration work more broadly, but that is too large a topic to cover here.

Regrowth provides a range of ecosystem services including provision of biodiverse habitat, improvement in water quality (e.g. riparian regrowth) and sequestration of carbon dioxide. Carbon sinks, the primary purpose of which is to sequester atmospheric CO_2, can be established by planting seedlings, sowing seed or by allowing plant communities to regenerate themselves. The latter is termed *regeneration* rather than *revegetation* (human planting of seeds and seedlings) and where it is assisted by management interventions it is termed *human-induced natural regeneration*. Vegetation that has been established by regeneration processes is often termed *regrowth*. However, regrowth to date has generally not been accepted by the Australian Government as accountable carbon sinks under the Kyoto Treaty. This position needs to be changed in order for regrowth to have a greater value to landholders and the Australian economy at large. We argue that recognising the carbon sequestration services provided by regrowth will improve its conservation status.

Based on our ecological expertise and landuse experience, Greening Australia considers that all regeneration (regrowth) that has occurred on land previously cleared by humans is *human induced regeneration*.

The process of human induced clearing is a fundamental trigger for regeneration. Exactly what caused the regeneration after clearing is immaterial. Greening Australia argues that the way a tree was established on Kyoto compliant land is immaterial. It should make absolutely no difference whether a patch of trees greater than 0.2 ha in area was established by seeds spread by a machine or by the wind. The issue is simply whether the trees occurred on land cleared prior to, or after 1990. Any tree (plant with the potential to grow greater than 2 m in height) established after 1990 on previously cleared land should be eligible.

The only complexity is accounting for ineligible trees. Greening Australia argues that ineligible trees are remnant trees. We suggest that remnant trees are defined as those that were present before and after 1990 and were greater than 2 m in height as of 1990.

Greening Australia contends that all native trees that have appeared (regrown) on previously cleared land should be eligible as a legitimate carbon sink as long as the right to clear or harvest said trees is retired.

Case Study - Assisted regeneration in Armidale, NSW

In 1994, a section of the town common (0.5 ha site on travelling stock route near the saleyards) was fenced and 5 lines were deep ripped. Weeds were sprayed on the site in preparation for a school tree planting. The fenced site also included a number of mature manna gum (*Eucalyptus viminalis*). As a result of the exclusion of grazing animals, ground disturbance and weed control, as well as a heavy seed crop on the existing trees, there was a good regeneration of manna gum, which is still growing strongly. Prior to fencing the site had been cleared for many years, leaving widely spaced trees (5% canopy cover) and continuous grazing had prevented any newly regenerating seedlings from growing or surviving.

Implications for carbon sinks

The site is clearly eligible for Kyoto compliance as it was cleared prior to 1990, had forest cover less than 20% and was larger than 0.2 ha. The trees established by regeneration around the mature (remnant) manna gums should be included in the carbon sink with the trees planted by the school. The fact that some trees established *in situ* from the parent tree while others established in a school nursery is immaterial to accounting for the additional carbon in the system. The only trees that may not be accounted for are the mature *E. viminalis* that were present long before 1990. The fundamental auditing data is a high resolution image such as an aerial photo.

Advantages of regrowth as a carbon sink

The table below shows the advantages and disadvantages of regrowth as a technique for establishing biodiverse carbon sinks.

Direct seeding	**Tubestock planting**	**Natural regeneration (regrowth)**
(+) Lower establishment costs	(+) More reliable	(+) Plants are well-adapted to the site.
(+) Natural look and more diversely structured	(+) Uniform	(+) Establishes healthiest plants
(+) Establishes healthier plants	(+) Revegetation is visible to passers by	(-) May have to wait for a long time for results
(-) Long establishment times may lead to more maintenance such as weed control.	(-) Often results in unnatural looking rows	(-) Needs an adjacent or nearby seed source
(-) Ants have been known to take seed	(-) Higher establishment costs	(+) Lowest establishment costs
(-) Uses lots of seed	(+) Uses small quantities of seed	(-) Long establishment times may lead to more maintenance such as weed control.

In conclusion, Greening Australia advocates the inclusion of regrowth native vegetation as legitimate carbon sinks that should be included in the planning for national and international trade in carbon. Recognising the carbon value of regrowth should provide a strong incentive to conserve regrowth, which given a chance, can become 'old growth for the grandkids'.

Acknowledgement

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References

Anderson, E.R. (1982). The native woody weed problem following brigalow development in Australia, in *The Brigalow Belt of Australia* (ed. A. Bailey). Queensland Department of Primary Industries, Brisbane, Qld.

Baskin, C.C. and Baskin, J.M. (1998). Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination. Elsevier Inc.

Bowen, M.E., McAlpine, C., House, A.P.N., and Smith, G.C. (2007). Regrowth forests on abandoned agricultural land: A review of their habitat values for recovering forest fauna. *Biological Conservation* 140, pp 273-296.

Dorrough, J., Moll, J., and Vesk, P. (2006). When is natural regeneration cheaper? Assessing the costs of getting trees on farms. Proceedings of Veg Futures 06: The Conference in the field. Albury, 19-23 October, 2006. Greening Australia.

Petrie, M. (ed.) (1999). Natural Regeneration: Principles and practice. Land for Wildlife Note No 8. Land for Wildlife program South-East Queensland.

Seabrook, L., McAlpine, C., and Fensham, R. (2007). Spatial and temporal analysis of vegetation change in agricultural landscapes: A case study of two Brigalow (*Acacia harpophylla*) landscapes in Queensland, Australia. *Agricultural Ecosystems and Environment* 120, pp 211-228.

Winfield, D., Curtis, D. and Morsley, R. (1998) Natural regeneration of trees: Case study 1 adjacent to Rural Lands Protection Board Depot. Greening Australia Field Note 98/2. Greening Australia, Armidale.

Considering regrowth in ecological assessments: where science, policy, legislation and assessment don't meet

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Introduction

In our opinion, regrowth is a term often used, or misused, by governments and consultants, regularly devaluing regrowth in generalised and unsubstantiated statements that consider regrowth and scattered native vegetation as highly degraded, unimportant, insignificant, or of no habitat value. Such simplistic notions of regrowth vegetation are without due consideration to their actual and potential values.

While the ecology of regrowth is complex, this short note introduces some common origins and types of regrowth, the often overlooked conservation values of regrowth, and the failure of governments and many practicing environmental consultants to recognise these values.

Origin and Types of Regrowth

Compare air photos from 1940-1960 to those from 1990-2000 to see how much of Australia is regrowth. Regrowth is a term that is generally used to describe areas of regenerating native vegetation (Bowen *et al.* 2007) usually after disturbance. There are many different types and ways of looking at regrowth, and each is treated somewhat differently by governments and in ecological assessments.

Regrowth is an important natural process in many Australian ecosystems after a fire event, a storm event, flooding or landslip. Human induced disturbances can also be a trigger for regrowth, for example, after logging in a forest (Doherty, 1998), land clearing for agriculture, cessation or alteration of grazing regime, cropping or slashing (Doherty, 1998; Bowen *et al.* 2007).

Floristic and structural attributes of regrowth are likely to be influenced by methods of clearance, type, duration and intensity of land-use prior to regrowth and subsequent natural and human disturbances, potentially resulting in new assemblages (Bowen *et al.* 2007) and vegetation missing whole strata. For example, the exotic Camphor Laurel (*Cinnamomum camphora*) mixes with native rainforest forests in the lowlands of north-east NSW, and grasslands which may be relict or regrowth of the groundlayer in what were once grassy woodlands.

Regrowth Values: a summary of the overlooked

Fauna

For fauna, regrowth habitat values have dynamic habitat qualities, ranging from unsuitable habitat, marginal or supplementary habitat, to suitable habitat depending on the regeneration stage of the vegetation (Bowen *et al.* 2007). Regrowth habitats:

- increase in species composition and richness of the fauna assemblage with increasing resemblance to intact forest (canopy ages and height increases)
- may be used by the many declining (distribution and numbers) temperate woodland birds in some landscapes, and as functional habitat (e.g. 'stepping stones') for threatened and non-threatened protected fauna species
- are often observed surrounding mature to over-mature tree specimen(s), act as foci for regeneration as birds perch and excrete seeds
- are critical for some species and individuals in heavily cleared areas, as habitat is cleared, animals move to and use what habitat is available
- reduce the time lag for additional resource availability in landscape thus increasing capacity for increasing population sizes.

Though more research needs to be undertaken to gather a clear understanding of the ecological values of regrowth to fauna, especially across multiple scales (site to landscape) (Bowen *et al.* 2007), even with our limited understanding of regrowth and its role in fauna conservation the considerable values are obvious.

Flora

Regrowth vegetation is often disregarded, with little recognition of its importance:

- for species persistence and adaptation to environmental changes at evolutionary scales
- for the seed bank as the expression of genetic diversity "*containing a mixture of genotypes can result from the production of seed over several growing seasons... contain seed resulting from distinct years of flowering and seeding*" (Given 1994)
- in increasing the diversity of pollen and genetic material available, increasing the effective population size, potentially increasing population viability

- as habitat for many populations of threatened plant species that often occur in regrowth, including the expansion of threatened plant populations, or populations part of endangered ecological communities
- as buffer zones at remnant edges, as recruitment of species, such as Eucalypts and Wattles, is often observed at the edges of remnants.

Failing the Conservation of Regrowth

The regrowth habitats under threat from development, and to a lesser degree from agricultural land clearing and private native forestry, ignored or devalued by governments and environmental consultants are mostly post agricultural regrowth, now in an urban, or ever increasing urban-rural matrix, e.g. Cumberland Plain Woodlands in Western Sydney, and within the coastal zone.

In NSW, Ecologically Sustainable Development is required to be considered in planning matters as an object of the *Environmental Planning and Assessment Act 1979*. Regrowth should be considered as part of achieving the object "conservation of biological diversity and ecological integrity, namely that the conservation of biological diversity and ecological integrity should be a fundamental consideration", and should include consideration to the three levels of biodiversity (genetic, species, community-ecosystem), irrespective of whether the vegetation is regrowth or not.

The Native Vegetation Act allows clearing for routine agricultural management activities (as defined in the Act and regulations) and the clearing of regrowth is generally permitted. Regrowth is defined in the Act as vegetation which has regrown since 1990 for the Central and Eastern Division of New South Wales (and 1983 in the Western Division). If the NV Act persists for another 50 years, regrowth which is 20 years old today, will be 70 years old then, and would be likely to be able to be cleared without any approval, still considered as regrowth.

Recher (1991) sums up the fundamental attributes of regrowth vegetation for fauna, as values now and in the future, stating "*a plant acquires new and challenging values for wildlife throughout its entire existence cycle from seed, through germination and growth, to maturity, death and decay. No part of the cycle can be ignored or considered unimportant in the management of forest fauna...*".

The ecological values of old growth forests for fauna have been well appreciated for decades, but, it seems that to the governments and among many environmental consultants, there needs to be a reminder that today's regrowth is tomorrow's old growth, and that in fact regrowth is part of the fundamental ecological processes of regeneration and succession.

References

Additional references can be provided by the authors

Bowen, M.E., McAlpine, C.A., House, A.P.N., and Smith, G.C. (2007) Regrowth forest on abandoned agricultural land: a review of their habitat values for recovering forest fauna. *Biological Conservation*. 140: 273-296.

Doherty, M. (1998) *The Conservation Value of Regrowth of Native Plant Communities: a review*. NSW Scientific Committee <http://www.environment.nsw.gov.au/resources/nature/RegrowthOfNativePlants.pdf> (accessed 16 July 2010).

Given, D.R. (1994) *Principles and Practice of Plant Conservation*. Timber Press, Portland, Oregon, USA.

Recher, H. (1991) The conservation and management of eucalypt forest birds: resource requirements for nesting and foraging. In Lunney, D. (Ed.). *Conservation of Australia's Forest Fauna*. Surrey Beatty & Sons Pty. Ltd, Chipping Norton, Australia.

‘Regrowth’ within reconstructed species-rich grasslands – observations of opportunities taken up by a range of trophic levels

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Regrowth and the subsequent benefits resulting from re-establishing vegetation (e.g. opportunities for re-colonization by other species) come in many forms. Most readily identifiable might be that which is associated with natural or man-induced disturbance such as re-growth of woody or shrub canopy following fire or clearing. However, I have noted that similar opportunities for ‘regrowth’, if this is viewed in a more expansive manner, may also be created following the consolidation of re-seeded species-rich herbaceous communities. This general restoration approach was tested by the Grassy Groundcover Restoration Project (GGRP), a partnership between Greening Australia (Victoria) and the University of Melbourne. Initiated in 2004 as a multi-regional restoration initiative across southern and western Victoria, the fundamental objective of the project was to demonstrate the effectiveness of direct sowing multi-species seed mixtures (representative of locally occurring remnant communities) on agricultural sites. However, it was also posited that, if successful, the goal of creating diverse and resilient native plant communities would in turn offer a range of niches and opportunities for colonization by other organisms from various trophic levels.

Since 2004 the GGRP has reconstructed species-rich grassland at over twenty locations covering approximately 30 ha. Indeed, in partnership with Alcoa at their Point Henry site located near Geelong the GGRPs goal is to reconstruct 150 ha of grassland over the next 15 years. Already 10 ha has been established. The most stable and diverse of these reconstructed communities occur under conditions where soil nutrient loads have been reduced. Nutrient restriction limits the capacity of weeds to dominate, improving potential for sub-dominant native species to establish and persist. One measure of the success of the GGRPs approach of setting a goal of high diversity early in the restoration cycle has been that, where complex vegetation has been maintained, colonization from other trophic levels has been observed.

In the communities established under nutrient restricted conditions there have been increases and expansion of the seeded populations through natural recruitment (or clonal expansion). Over time the structure of these communities has typically become increasingly heterogeneous as successional processes reveal individual plant and species relations developing and altering. For example, the presence of pioneer species typically declines as slower developing stress-tolerators begin to consolidate spatially and temporally. This temporal aspect of vegetation development is obvious in the grass matrix as individuals develop as larger (dominating) tussocks or as mats of forb species spread and occupy large areas within sites.

These images of Plovers eggs and a Plains Froglet are a few among many different animal species we now find residing in our reconstructed grasslands. Photos: Paul Gibson-Roy

As these processes unfold surveys have revealed the ingress of many non-introduced (i.e. through the seeding program) organisms, both plant and other, increasing the complexity of these systems. In regard to those plant species not included in the seed mixes, natural recruitment from native over-storey species has been noted at many sites. For example, where resident eucalypts adjoin seeded areas (e.g. as roadside remnants or paddock trees), tree seedlings have emerged within the swards (to be managed as desired). At other sites, where for example once endemic Blackwoods (*Acacia melanoxylon*) are absent, individuals have been recorded emerging from the soil seed bank. Particularly interesting are conversations with landholders that reveal, at some of these locations, Blackwoods have not been present in living memory.

Many other non-plant species now inhabit our reconstructed grasslands. Because the project was undertaken in farming systems (e.g. cropped or grazed), cryptogamic layers were absent in or near the seeded areas. However, now it is common to find moss and lichen layers forming at sites. Species-rich remnant grasslands are known to harbour a diverse range of native invertebrate species, including spiders, butterflies and moths. Encouragingly, insect surveys in these seeded grasslands have revealed many colonizing native invertebrate species. Conversely, they were not found to be a feature of the low diversity (primarily introduced) vegetation found in adjoining areas. Native spiders are now a feature in the spring, spinning webs between grass culms, while native butterflies congregate on the bare ground between plants and other 'bugs' occupy a range of niches therein.

As the plant communities have developed, vertebrate species have been observed utilizing or residing within our grasslands. For example, burrowing activity of small native mammals and reptiles in, under and around older grass tussocks and within clumps of forb biomass is regularly noted. I also routinely observe parrots grazing grass seed or am startled when birds (e.g. quails) scatter underfoot and look down to see nests and eggs. While not easy to locate, I have also found frogs and reptiles within our reconstructed swards. It is likely that the range of invertebrates offer both a reliable and attractive food source.

At the subterranean level 'regrowth' also seems to be occurring. Preliminary investigations of plant roots have shown the presence of structures that are associated with functioning arbuscular mycorrhizal. This mutualistic relationship between the plant and its fungal symbiont is thought to confer benefits not only to those parties, but indirectly to other organisms that rely on functional plant communities for food and/or shelter.

In conclusion, in the process of undertaking the GGRP it has been greatly encouraging to discover that not only is it possible to reconstruct species-rich grassland (or herbaceous communities), if properly managed, these then present a wonderful opportunity for 'regrowth' of another type. This 'regrowth' is typified by the influx of non-sown species representing a range of organisms and trophic levels. If persistent, this influx enhances the diversity and function of the reconstructed community. Such novel restoration approaches provide restorationists with another opportunity to increase the range and quality of plant and animal communities in highly modified areas of Australia.

Fencing to exclude livestock grazing enhances biodiversity values of remnant York Gum–Jam woodlands in Western Australia

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The wheat and sheep farming district of south-west Western Australia, known locally as the wheatbelt, retains an extraordinarily rich biological diversity despite extensive clearing of native vegetation and widespread land degradation. The unique features of the wheatbelt, including the ancient nutrient-impoverished soils and its relatively recent development for agriculture, make it difficult to predict limits to biodiversity persistence and recovery compared to agricultural landscapes elsewhere (Prober & Smith 2009; Standish & Hobbs 2009). Despite a long history of natural resource management programs that support biodiversity conservation in the region, the effectiveness of one of the oldest and most widespread interventions—fencing remnant vegetation to manage livestock grazing—has rarely been tested.

Our research project

We compared vegetation and soil condition in 29 unfenced and 29 fenced sites (paired), and 11 reference sites in York Gum (*Eucalyptus loxophleba* subsp. *loxophleba*)–Jam (*Acacia acuminata*) woodlands within the Avon catchment. These woodlands are rated high priority for biodiversity conservation. Fenced sites had been fenced for between two and 22 years, and reference sites (the least degraded woodlands we could find in the region) were selected as benchmarks.

We tested two specific hypotheses:

1. Fencing facilitates recovery of degraded York Gum–Jam woodlands towards conditions of the reference woodlands; and
2. Recovery of degraded woodlands towards reference condition after fencing is constrained by ecological or other limits.

What did we find?

Consistent with our first hypothesis, we found that fenced sites differed significantly from unfenced sites in species richness of most groups of native plants, native cover, exotic cover and tree recruitment, and the direction of these differences was generally towards reference conditions. Further, frequency of Jam increased with increasing time since fencing, exotic cover decreased with time since fencing, and fenced plots were more similar to reference plots in floristic composition than unfenced plots were. However, soil nutrient levels in topsoils did not differ between fenced and unfenced sites.

Our second hypothesis was also supported for most condition measures. On average, soil nutrients were elevated, exotic cover was higher, and native richness was lower in fenced compared with reference sites, and ordination analyses suggested soils and understorey of fenced sites reached reference condition in only a small subset of cases. This may be partly due to lack of sufficient time since fencing, but regression analysis suggested that recovery from exotic invasion is more limited at higher soil nutrient levels, and that recovery of native species richness is constrained by the persistence of exotics. On the other hand, recruitment of Jam in fenced sites was similar to that in reference sites. York Gum recruits were absent from 81 per cent of all sites (including reference sites), but there was a pulse of recruitment in some fenced plots that suggested fencing can enable episodic recruitment in conjunction with other disturbances (Fig. 1).

We conclude that fencing to exclude livestock grazing is often effective for enhancing the biodiversity conservation values of remnant York Gum–Jam woodlands. However, additional interventions are likely to be necessary to promote restoration in some cases, particularly where a lack of native propagules, elevated soil nutrients and concomitant invasion by exotic species, prevent the recovery of native species.

The full report (Prober *et al.* 2009) is available from the authors or from Wheatbelt NRM Inc. <http://www.wheatbeltnrm.org.au>.

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References

Prober, S.M. and Smith, F.P. (2009). Enhancing biodiversity persistence in intensively-used agricultural landscapes: a synthesis of 30 years of research in the Western Australian wheatbelt. *Agriculture Ecosystems and Environment* 132, 173-91.

Prober, S.M., Standish, R.J. and Wiehl, G. (2009). After the fence: condition of fenced, unfenced and reference York Gum – Jam woodlands in the Avon Catchment, Western Australia. CSIRO Sustainable Ecosystems and Sustainable Agriculture Flagship, Perth.

Standish, R.J. and Hobbs, R.J. (2009). Restoration of OCBILs in south-western Australia: Response to Hopper. *Plant Soil* DOI 10.1007/s11104-009-0182-z.

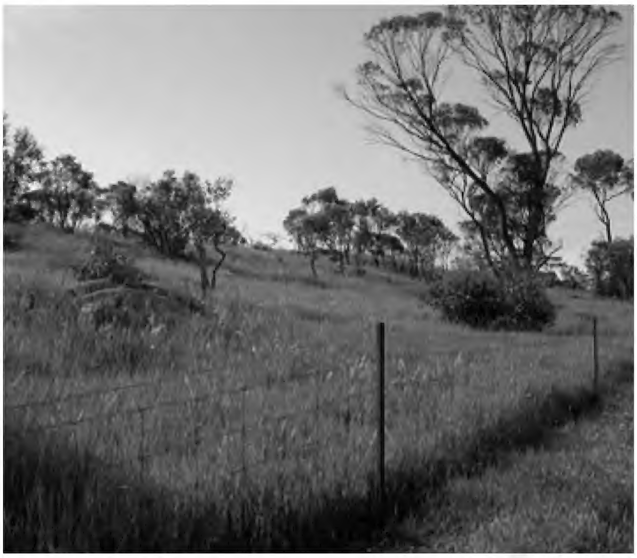

Figure 1. A fenced remnant of York Gum–Jam woodland showing significant York Gum recruitment. This site was fenced and burnt in c. 2003. No recruitment was evident in the near-by unfenced plot, which was burnt at the same time. © 2009 CSIRO. Photo: Suzanne Prober

Climate change and threatened wetland flora and communities

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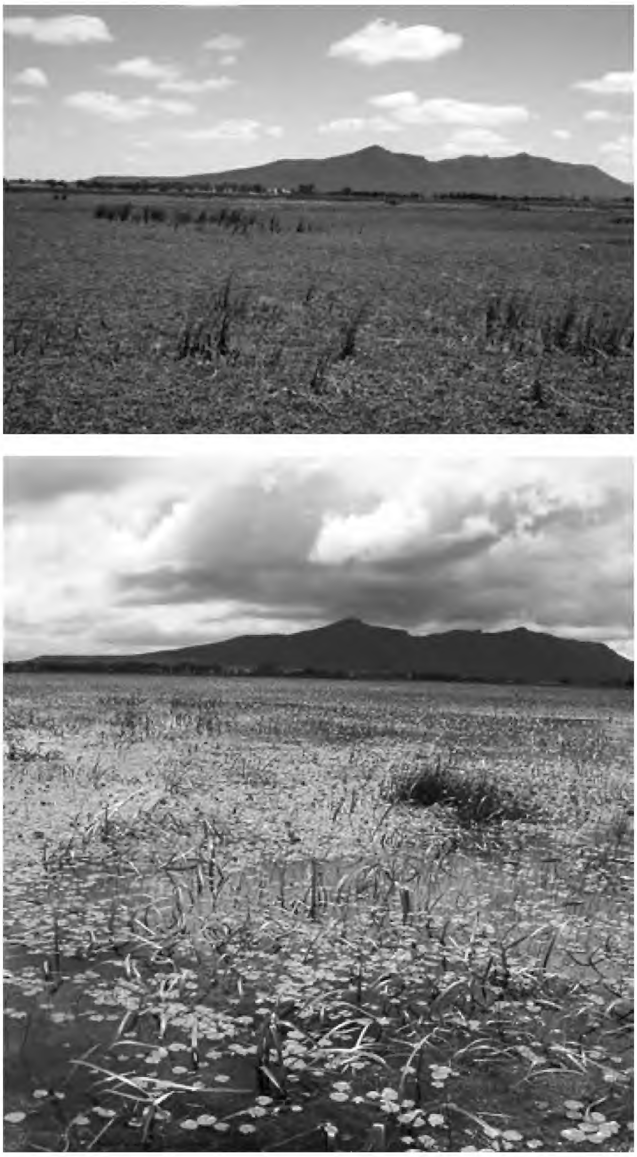
Wetland and riparian plant communities have been extensively cleared or affected by land uses that have altered hydrological processes and salinity regimes across much of the Australian continent. Vegetation communities most damaged by these processes include those which occur on fertile lowland plains that have been subject to drainage, nutrient inputs, cropping and grazing and those associated with lowland river systems that have been subject to extensive regulation, including the Murray-Darling system.



Bryan's Swamp during drought (top) and after 'average' rainfall (bottom). Photos: Damien Cook

As a consequence many of the wetland and riparian environments of the lowland plains of Western Australia, South Australia, Victoria, Tasmania, New South Wales, the Australian Capital Territory and Queensland are in an ecologically degraded condition. Where they remain either partially or comparatively intact these environments often support a range of threatened species and communities.

Threats from climate change

Potential impacts of climate change that place these already threatened species and communities at even greater risk of extinction include:

- sea level rise, which would cause some coastal wetlands to become marine embayments and drown other coastal ecosystems including Mangroves, Saltmarshes, Dune Systems and eventually low-lying coastal plains. Equilibrium sea level rise for the current atmospheric carbon concentration of 385 ppm is several metres (Hansen *et al.* 2008);
- more frequent storm surges, increasing the frequency and volume of saline intrusion into river estuaries, salt marshes and other coastal ecosystems;
- increased frequency and intensity of wildfire, which will reduce run-off, increase sediment inputs to wetlands, cause pulsed nutrient releases which may lead to algal blooms and alter the species composition of certain plant communities;
- the spread of weeds and feral animals across larger areas of Australia, including species such as Water Hyacinth (*Eichhornia crassipes*), Alligator Weed (*Alternanthera philoxeroides*) and Cane Toad (*Bufo marinus*), as average temperatures increase;
- extinctions of inter-related flora and fauna species, such as pollinators or seed dispersers, as local climates (temperature, humidity and precipitation patterns) become unsuitable, particularly in specialized habitats such as alpine areas; and
- changed rainfall patterns, which will modify the structure and composition of native vegetation, with flow on effects to native animals. For example modeling of future climate change predicts that over much of Victoria winter and spring rainfall will decrease, while summer rainfall may increase.

Examples of species and communities at risk

Ridged Water Milfoil (*Myriophyllum porcatum*) is a nationally vulnerable species that is directly threatened by decreases in winter rainfall. Little is known about the ecology of this annual species, but field observation suggests that it only grows and reproduces successfully following autumn or early winter inundation of its seasonal wetland habitat (Eris O'Brian pers. comm.). It does not appear to respond to flooding in late winter, spring or summer.

Many shallow seasonal wetland types in southern Australia, such as the *Environment Protection and Biodiversity Conservation Act 1999* nominated Temperate Lowland Plains Grassy Wetland, rely on winter rainfall to wet soil profiles and sustain inundation through late winter and spring to maintain ecological processes. Without adequate winter rainfall the soil of such wetlands does not retain enough moisture for inundation to occur. Therefore patterns of reduced winter rainfall will have serious negative impacts on these wetland types and the many species of threatened flora and fauna that rely on them.

Environmental water requirements

In order to survive and flourish wetland and riparian environments need adequate water at the right time of year. Where river regulation has occurred allocating water for the environment can be part of the solution in maintaining populations of threatened species.

In Autumn 2008 the Goulburn Broken Catchment Management Authority delivered environmental water allocations to three stressed wetlands in northern Victoria, including Black, Reedy and Kinnairds swamps in the Goulburn Broken Catchment. This watering stimulated the growth of the largest population of the Ridged Water Milfoil ever documented, including many thousands of plants over several hectares, in an area of seasonal Temperate Lowland Plains Grassy Wetland at Kinnairds Swamp. While inundation of this area was relatively brief it enabled successful growth and seed set of the milfoil, thus assisting in its long-term survival at this site. Seed was also collected from this area for the Millennium seed bank project, providing the possibility of *ex situ* species recovery if this becomes necessary.

Reference

Hansen, J., Sato, M., Kharecha, P., Beerling, D., Masson-Delmotte, V., Pagani, M., Raymo, M., Royer, D.L., and Zachos, J.C. (2008). Target Atmospheric CO_2: Where Should Humanity Aim? *Open Atmospheric Science Journal*, vol. 2, pp. 217-31.

Decline of *Ruppia* species in the Coorong lagoons, SA

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Introduction

The *Lower Murray River and associated wetlands, floodplains and groundwater systems from the junction of the Darling to the sea* (River Murray-Darling to Sea) ecological community is currently being assessed for listing under the *Environment Protection and Biodiversity Conservation Act 1999*. One of the listing criteria used to assess the threatened ecological community status, Criterion 3, is the 'loss or decline of functionally important species'. In the Coorong, the decline of aquatic macrophytes (water plants) is likely to meet this criterion, although this will not be certain until the assessment is complete in 2011.

Two important macrophytes are species of *Ruppia* (Widgeon Grass) which are considered to have historically been keystone species in the Coorong (Phillips and Muller 2006). Both have essentially disappeared from their original ranges in the Coorong since the 1990s. This article summarises the ecological role of these plants, changes in their distribution in the Coorong, causes of their decline and what needs to be done to encourage their return.

Ecological roles of *Ruppia* species

Ruppia megacarpa is widespread in brackish to hypersaline coastal lagoons, estuaries and inland lakes (preferred salinity range 5-46‰ total dissolved solids (TDS): seawater salinity is 35 ‰ TDS). It usually grows as a perennial plant in permanently inundated areas (Nicol 2005). *Ruppia tuberosa* grows exclusively in hypersaline conditions (preferred range 40-80 ‰ TDS; Paton pers. comm. 2010) and is often found in ephemeral saline wetlands. *Ruppia tuberosa* functions as an annual, dying when water levels fall and regenerating from seeds or asexual propagules called turions when favourable conditions return. Both species require relatively high light environments, with *R. megacarpa* restricted to water < 2 m deep and *R. tuberosa* to water < 1.0 m deep (Nicol 2005). Both species are also extremely sensitive to dessication, so do not grow in water less than about 0.3 m deep because wind-driven waves in the Coorong can change water levels by this amount during the course of a day (Paton 2010).

Ruppia species historically fulfilled two key ecological roles. First, they were the main primary producers in the hypersaline environment of the Coorong. Swans, ducks and fish fed on the leaves and seeds of both species and on the starchy turions of *R. tuberosa*. *Ruppia* species were probably also the main source of detritus in the Coorong (Phillips and Muller 2006). Second, they provided shelter for invertebrates and small fish, and substrates for algal growth as well as for egg deposition for small fish in the soft-sediment, high-energy environment of the South Lagoon (Rogers and Paton 2009).

Changes in historical distribution

Historically, *R. megacarpa* formed extensive beds along the length of the North Lagoon of the Coorong (Paton 2010; Phillips and Muller 2006). These beds disappeared completely sometime between 1995 and 2003, and by 2007 their propagule banks had also disappeared with the exception of a very few seeds of doubtful viability (Nicol 2007).

Likewise, *R. tuberosa* once grew extensively on shallow, seasonally inundated mudflats throughout the South Lagoon. During the early 2000s, *R. tuberosa* began to decline sharply in abundance, first at the southern end of the South Lagoon, then at northern sites as well (Paton 2010). By 2007 it had almost completely disappeared from the South lagoon, including most of its propagule beds. However, from about 2005 a small and tenuous population of *R. tuberosa* began to establish itself at the southern end of the North Lagoon. This is now the only similar population of aquatic macrophytes in the entire Coorong.

The fish and invertebrates that depended on the *Ruppia* beds provided food for a wide range of waterbird species including terns, grebes, pelicans and migratory waders. As a combined consequence of extreme salinity and the loss of the food chains supported by *Ruppia* species, these waterbird populations have declined alarmingly in recent years (Paton 2010).

Causes of the decline of *Ruppia* species

Four main factors are believed to have caused the decline of *Ruppia* species and their dependent communities. These are: salinity levels too high (toxicity); water levels too low at key times preventing reproduction of *R. tuberosa*; lack of freshwater pulses at key times preventing reproduction of *R. megacarpa*, and; the loss of the propagule banks (Nicol 2005; Paton 2010). All of these factors can be directly traced to the very low flows of water over the barrages at the Murray Mouth (Paton 2010; Rogers and Paton 2009).

Restoring *Ruppia*

Paton (2010) estimates that for *R. tuberosa* to reestablish in the South Lagoon, the salinity range would need to be lowered to 60-100‰ TDS. Water levels between 0.3-0.9 m would need to be maintained over the mudflats of the South Lagoon from June until at least December to permit reproduction. Ideally, this would involve restoring flows of at least 3000 GL/year over the barrages (compared to long-term historical flow of 12000 GL/year) for several years. Considering present low or absent flows, pumping hypersaline water out of the South Lagoon into the ocean is a practicable alternative in the short term (Paton 2010). Once salinity levels are returned to below 100‰ TDS, lower salinity levels could be maintained with lower quantities of water, with a minimum of 300 GL in a dry year.

To restore *R. megacarpa,* it has been suggested that salinities within most of the North Lagoon and Murray Mouth should be permanently maintained below 46‰ TDS (Nicol 2007). However, for this to occur, the Murray Mouth needs to remain open. Freshwater pulses from releases past the barrages at the Murray Mouth would also need to occur regularly. Presumably, the flow regime recommended by Paton (2010) for *R. tuberosa* would also be suitable for *R. megacarpa*, if it could be reestablished.

The loss of most of the propagule bank for each species is a further impediment to restoration, and re-seeding may be necessary. If this is done, then pilot trials should be undertaken first to determine whether suitable conditions for re-establishment have been achieved and if larger-scale restoration is likely to be successful.

By far the biggest challenge in restoring *Ruppia* in the Coorong, and indeed the on-going health of the entire River Murray-Darling to Sea ecological community, is to ensure that enough water is retained in the river for environmental flows. There are many relevant Commonwealth and State government initiatives and planning processes underway at present that will work toward this goal. However, only time will tell if *Ruppia* will return.

References

Nicol, J. (2005). *The ecology of Ruppia spp. in South Australia, with reference to the Coorong : a literature review*. SARDI Aquatic Sciences, West Beach, SA.

Nicol, J. (2007). *Impact of barrage releases on the population dynamics of Ruppia megacarpa in the Murray estuary and North Lagoon of the Coorong.* Progress Report 2006/07, South Australian Research and Development Institute (Aquatic Sciences), Adelaide.

Paton, D.C. (2010). *At the end of the river: the Coorong and Lower Lakes*. ATF Press, Hindmarsh, South Australia.

Phillips, W. and Muller, K. (2006). *Ecological Character Description: Coorong, Lakes Alexandrina and Albert Wetland of International Importance*. SA Department for Environment and Heritage, Adelaide.

Rogers, D.J. and Paton, D.C. (2009). *Changes in the distribution and abundance of Ruppia tuberosa in the Coorong*. Water for a Healthy Country Flagship Report series, CLLAMMecology Research Cluster, Adelaide.

Long-stem planting

Marjo Patari

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Development of the long-stem planting method in Australia has seen an increase in the survival rates of seedlings planted in many different environments. The advantages of this method, such as no post-planting watering, increased growth rates and higher survival rates, have made a positive contribution to many rehabilitation projects and seen individuals and groups obtain successful outcomes in areas that were considered a challenge.

What is long-stem planting?

The long-stem planting method is an innovative way of planting that can result in higher survival and growth rates with minimal post-planting care. Seedlings are grown in pots for 10-18 months, so that they develop long woody stems. These seedlings are then planted with about three-quarters of their length below the soil surface which results in much of the woody stem being covered with soil. Once planted, the seedling develops roots from the buried stem and leaf nodes. This promotes the development of a robust root network which gives the seedling a greater chance of survival.

The long-stem planting method has challenged two long-held horticultural principles:

1. Large plants should not be grown in small containers as they will become root bound, thereby hindering the future growth of the plant.
2. Stems of seedlings should not be planted below the surface of the soil as this subjects them to fungal attack and disease.

Field trials using the long-stem method with a variety of native species have demonstrated that seedlings can not only be grown successfully when these two traditional principles are not followed, but can have survival and growth rates that exceed those planted using traditional planting methods (Australian Plant Society 2010).

How the long-stem method was developed

The long-stem planting method was pioneered by Bill Hicks in the Hunter Valley. The spread of willows had become an environmental problem and Bill wanted to establish native species on river banks instead of willows (*Salix* spp) as was the recommended practice at the time

The riparian environment presents challenges for the planting of natives using traditional planting methods as the seedlings are continuously affected by changes in water levels, river flow, and processes of erosion and sedimentation. Bill developed and tested the long-stem planting method such that seedlings were able to be planted more deeply into the soil and thus found a way to reintroduce native species to riverbanks (Australian Plant Society 2010). Individuals and groups have since conducted scientific field experiments to examine the effectiveness of the method in a range of habitats, including rainforest, sand dunes and saline sites.

General benefits

The benefits of the long-stem planting method are significant and include advantages which are of great assistance to bush regenerators and others interested in plant survival:

- the deeply-planted root ball is insulated from the substantial changes in soil temperature and moisture;
- the deeply-planted root ball accesses nutrients and soil moisture that is beyond the reach of shallow-rooted weed species. This reduces the level of competition with shallow-rooted species;
- in drier and saline environments, planting more deeply allows the root ball to be further away from the hot, dry or damaging salt-encrusted topsoils which increases the seedling’s chances of survival;
- long-stem seedlings are more stable in the ground and are better able to withstand soil erosion due to wind such as on sand dunes, or the effects of moving water such as flood conditions in riparian zones;
- long-stem seedlings require relatively small quantities of water when planting, and no further watering is required post-planting. This benefit is important on sites with limited water;
- seedlings can survive trampling by people walking through planted areas;
- reduced loss from vandalism as it is difficult to pull up a deeply-planted root ball; and
- the long-stem method creates an older, stronger seedling for planting.

Riparian environment

The main benefits of using the long-stem method within the riparian context is that the roots of seedlings are planted more deeply into the river bank therefore the seedling is not washed away during a flood event. In original trials in the Hunter Valley, Bill Hicks found that three of the four species planted, such as River Red Gum*, Eucalyptus camaldulensis,* exhibited greater growth rates using the long stem method. Bill showed that native plants could be reintroduced into riparian environments using the long-stem planting method where previous planting trials had not been effective.

Rainforest environment

Research conducted in the rainforest at Holgate, NSW, has indicated that some species, such as the Cheese Tree, *Glochidion ferdinandi*, show significantly greater growth rates when planted as long-stem seedlings. The long-stem seedlings often do not reach 1 metre high when grown in the pots. However, this does not affect their ability to be planted deeply using this method. Field trials using a larger number of rainforest species are currently being undertaken to further study long-stem planting within rainforest environments.

Coastal environment

Long stem plants in sand dunes benefit from having reliable soil moisture, limited root competition, and stable soil temperatures. The likelihood of the root ball being exposed in dunes as a result of sand movement is reduced when the long stem planting method is used. At Patonga Beach (Central Coast, NSW) the long-stem planting method has been used in trials of Coastal Wattle, *Acacia longifolia* var. *sophorae*, to restore the beach dune area. Results of these trials concluded higher survival and growth rates with plants using the long-stem planting method (Bakewell *et al.* 2009).

The advantages of using the long stem planting method in this environment include the elimination of the need to build structures around the seedlings to protect them and elimination of the need for post-planting irrigation. This can significantly reduce the costs associated with regeneration work and the amount of follow up maintenance required at the site.

Saline environment

There has been great success in the use of long-stem planting within saline environments. Bill Hicks planted 2,500 long-stem salt-tolerant seedlings in the Upper Hunter. Some of the species used included *Eucalyptus botryoides*, *Eucalyptus tereticornis, Eucalyptus robusta*, *Melaleuca styphelioides*, *Melaleuca linariifolia*, *Melaleuca quinquenervia, Acacia binervia*, *Acacia saligna*, *Casuarina glauca* and *Casuarina cunninghamiana.* The trees survived a record drought, above-average temperatures and frosts as well as high salinity levels.

The main benefit of this method in a saline environment is that the root system is planted below the salt encrusted top layer of the soil. Soil salinity is damaging because it reduces the ability of plants to take up moisture and nutrients. As in other areas, deep planting also protects the root ball from surface frosts and drying out.

Conclusion

Long-stem planting has shown to be successful in a wide range of environments and conditions and the method provides an opportunity to improve the survival rate of native plants in the restoration of degraded ecosystems.

For further information on this planting method download *The Long-stem Planting Guide* from The Australian Plants Society website at <http://www.australianplants.org/> or obtain a hard copy of the Long-stem Planting Guide email the NSW Environmental Trust at info@environmentaltrust.nsw.gov.au or on (02) 8837 6093.

The Long-stem Planting Guide provides a step by step guide to this innovative method of planting which has applications for community groups and organisations involved in bush regeneration works, land management and natural resource management.

References

Bakewell, G., Raman, A., Hodgkius, D. and Nicol, H. (2009). Suitability of *Acacia longifolia* var. *sophorae* (Mimosaceae) in Sand Dune restoration in the Central Coast of New South Wales, Australia. *New Zealand Journal of Forestry Science* Vol. 39, 5-13.

Australian Plant Society (2010). The Long-stem Planting Guide. Australian Plants Society NSW Ltd. Central Coast Group <http://www.australianplants.org> (accessed 16 July 2010)

ANPC in the USA: directions in science and conservation at the Smithsonian Institution

Zoë Smith

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I am currently a postdoctoral fellow at the Smithsonian Environmental Research Center, Edgewater, Maryland, USA. This regular report covers some of my experiences in environmental research in the United States and provides recent highlights in science and conservation in the USA. An introduction to this regular report and background on SERC can be found in the 2009 September – November issue of APC.

Spring has sprung and the bugs are biting

After the shock of the unusually snowy winter, the forests around SERC are coming to life again. Even in the heart of Washington DC the wildflowers are blooming; front yards are filled with colourful tulips full and bright as though freshly ironed. As the leaves unfurl and the insects begin to hum, scientists at SERC are venturing out of their winter office hibernation and heading back into the field.

SERC has been lucky enough to host a mother and fledgling Bald Eagle, almost ready to leave the nest (the date of which has become another source of bets); and the back road has been closed in the evenings to protect the many frogs, toads, salamanders and turtles that venture out in the spring rain. Along with the vibrant wildlife a score of interns has arrived for the summer and the atmosphere is buzzing like the new bee colonies that have been installed to educate the community about their contribution to ecosystem services and implications of the decline in their abundance. Unfortunately the buzzing insects also include the persistent biting Deer Fly, which I have found can turn calm joggers into flailing-armed maniacs.

Whilst attending the annual Wintergreen Wildflower Symposium in the spectacular Blue Ridge Mountains in Virginia, I saw fields of blooming perennial *Trillium* species (Trilliaceae) and clusters of Pink Lady Slipper (*Cypripedium acaule*) orchids, which seemed out of place on the rocky ridges. Unfortunately I still haven't seen a bear, though the locals insist they're out there. I have personally celebrated plant life whilst raiding our vegetable garden of fresh strawberries, and am eagerly watching the blackberry and blueberries begin to bloom along the sides of our old winding street.

Science highlights

200 million year old ferns

I have been lucky enough to partake in a collaborative project to understand the growth rates and genetic structure of the clonal fern species, *Osmunda claytoniana.* Commonly named the Interrupted Fern, the species is distinguished by the production of brown fertile leaflets in between green sterile leaflets, effectively 'interrupting' the green foliage. The species is one of the most ancient living ferns, with fossils of highly similar plants dating back 200 million years. Preliminary growth measurements of underground rhizomes indicate that plants spread vegetatively at a rate of less than 1cm per year. Molecular studies of clone size will help to reveal the age of the ferns (currently predicted to be hundreds of years, with bets still being placed) and whether they are the oldest plants in the forest.

Genetic diversity prevents vole attacks

SERC scientists have demonstrated the positive effects of genotypic diversity of Evening Primrose (*Oenothera biennis*) on reduced vole herbivory and overall plant fitness. The positive effects of genotypic diversity were enhanced by the presence of deer through the selection of plant traits related to defence mechanisms: *Ecology Letters* 13(5), pp. 553-563

Hungry caterpillars in tasty forests

The woolly bear caterpillar (*Pyrrharctia isabella*), a generalist herbivore that feeds on many of the plants in the forests around SERC, was experimentally fed extracted plant essences to determine whether it preferred eating native or exotic plants. While the caterpillar had distinct plant preferences, these were not related to whether plants were invasive, casting doubt on the theory that invasive plants are more resistant to herbivory because of novel chemical defences: PLoS ONE 5(5): e10429. doi:10.1371/journal.pone.0010429

Radio transmitters reveal movements of orchid bees

Scientists at the Smithsonian Tropical Research Institute in Panama have discovered a novel method of tracking the routes of blue-green orchid bees (*Exaerete frontalis*) by gluing tiny (300 mg) radio transmitters to their backs. Radio signals reveal that the bees mostly remain local but can travel distances of up to 5 km, even crossing over the shipping lanes in the Panama Canal. Therefore the bees have an important role in long-distance gene flow among orchids: <http://smithsonianscience.org/>.

Science on the mall: Smithsonian Folklife Festival

From 1st-5th July, Smithsonian scientists will set up their own gypsy-style tent village on the National Mall in Washington DC, a 2 km stretch of lawn between the Capitol Building and the Lincoln Memorial, and lined with Smithsonian museums. The festival provides an opportunity for the general public to find out what scientists really do, and what is so intrinsically fascinating about the things they dedicate their lives to studying in intricate detail: <http://www.festival.si.edu/>. The festival also provides a good excuse to get out of the lab and enjoy the festivities of the Fourth of July holiday, which commemorates America's 234th year since the declaration of independence from Great Britain.

SERC opened the doors of the labs on the 14th of May with their annual Open House day. A record number of visitors enjoyed face painting, rides on tractors, boats and the electric powered 'eco-shuttle', live demonstrations of local marine life and how it is studied both in the lab and using remote controlled underwater video cameras. A particular highlight of the day was the annual 'wade-in' in the Rhode river (a sub-estuary of the Chesapeake Bay), which has been a tradition for more than 40 years. Participants measured the clarity of the river water by seeing how far they could walk in before their feet were no longer visible, recording a visibility 'wade-in depth' of 30.5 inches. More details and photos can be found at the SERC blog 'shorelines': <http://sercblog.si.edu/>.

Updates on the oil spill

The Smithsonian Museum of Natural History has opened a window to ocean life with the development of the Ocean Portal website, where you can learn all about giant squid, mangrove ecology and sustainable fisheries: <http://ocean.si.edu/>. The featured 'ocean newsroom' continues to provide updates on the disastrous oil spill in the Gulf of Mexico, and efforts to contain and mitigate the effects on marine life.

Report from New Zealand Plant Conservation Network

Danielle Hancock

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Popular Shopping Cart

The upgraded shopping facility on the NZPCN website has proven to be a big hit with many keen botanists taking advantage of the credit card options. Within the first two weeks of launching the new shopping cart NZPCN had received more than $3,000 worth of sales. The most popular choice was the new *Threatened Plants of New Zealand* book. We still have more copies available including an option of posting them overseas so place your orders now.

Second Marae-Based Course Almost Complete

Following on from the Plant Identification course book, the NZPCN is close to releasing the second course book in the series, Managing Conservation Covenants. This course will cover all practical advice around how to manage a covenanted area, including fencing, pest control, and monitoring. Check out the website for updates on progress.

Illustrated guide to New Zealand sun orchids by Jeremy Rolfe and Peter de Lange

This new book has recently been added to the shopping cart on the website and is available for purchase. This great field guide helps you identify *Thelymitra* species found in New Zealand and includes some lovely colour images. The authors have kindly allowed it to be listed on the NZPCN website, and any sales of this book will also provide a small donation towards the network. You can purchase the book for only NZ $28 which includes postage to Australia.

For more information on any of these items please check out our website at <http://www.nzpcn.org.nz>.

Research Roundup

Compiled by Kirsten Cowley, Centre for Plant Biodiversity Research, Canberra

Cheal, D. (2010). **Twenty years of grazing reduction in semi-arid woodlands.** *Pacific Conservation Biology* 15: 268-77.

Collard, S.J. and Fisher, A.M. (2010). **Shrub-based plantings of woody perennial vegetation in temperate Australian agricultural landscapes: What benefits for native biodiversity?** *Ecological Management & Restoration* 11(1): 31-5.

Cunningham, S.C., Thomson, J.R., Read, J, Baker, P.J. and Nally, R.M. (2010). **Does stand structure influence susceptibility of eucalypt floodplain forests to dieback?** *Austral Ecology* 35(3): 348-56.

Fischer, J., Stott, J. and Law, B.S. (2010). **The disproportionate value of scattered trees.** *Biological Conservation* 143(6): 1564-1567.

Gilman, S.E., Urban, M.C., Tewksbury, J., Gilchrist, G.W. and Holt, R.D. (2010). **A framework for community interactions under climate change.** *Trends in Ecology & Evolution* 25(5): 325-31.

Kanowski, J. (2010). **What have we learnt about rainforest restoration in the past two decades?** *Ecological Management & Restoration* 11(1): 2-3.

Kodym, A., Turner, S. and Delpratt, J. (2010). ***In situ* seed development and *in vitro* regeneration of three difficult-to-propagate *Lepidosperma* species (Cyperaceae).** *Australian Journal of Botany* 58(2): 107-14.

Michael, D.R., Lindenmayer, D.B. and Cunningham, R.B. (2010). **Managing rock outcrops to improve biodiversity conservation in Australian agricultural landscapes.** *Ecological Management & Restoration* 11(1): 43-50.

Powell, M., Accad, A., Austin, M.P., Low Choy, S., William, K.J. and Shapcott, A. (2010). **Predicting loss and fragmentation of habitat of the vulnerable subtropical rainforest tree *Macadamia integrifolia* with models developed from compiled ecological data.** *Biological Conservation* 143(6): 1385-96.

Price, J., Gross, C.L. and Whalley, W. (2010). **Prolonged summer flooding switched dominance from the invasive weed Lippia (*Phyla canescens*) to native species in one small, ephemeral wetland.** *Ecological Management & Restoration* 11(1): 61-3.

Ruthrof, K.X., Bell, R. and Calver, M. (2010). **Establishment of *Eucalyptus gomphocephala* (Tuart) woodland species in an abandoned limestone quarry: effects after 12 years.** *Pacific Conservation Biology* 15: 278-86.

Smith, Z.F., James, E.A. and McLean, C.B. (2010). **Mycorrhizal specificity of *Diuris fragrantissima* (Orchidaceae) and persistence in a reintroduced population.** *Australian Journal of Botany* 58(2): 97-106.

Spooner, P.G., Lunt, I.D. and Smallbone, L. (2010). **Using growth-form attributes to identify pre-settlement trees in central NSW, Australia.** *Australian Journal of Botany* 58(3): 188-97.

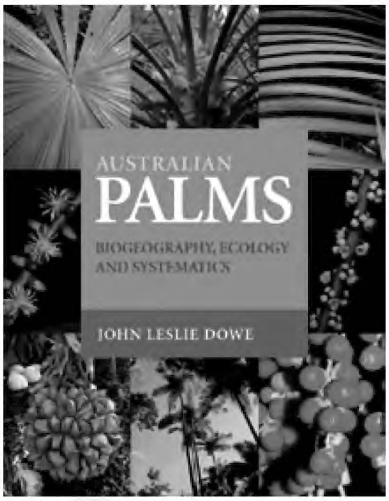
Szabo, J.K., Briggs, S.V., Lonie, R., Bell, L., Maloney, R., Joseph, L.N., Hunter, I. and Possingham, H.P. (2010). **The feasibility of applying a cost-effective approach for assigning priorities for threatened species recovery with a case study from New South Wales, Australia.** *Pacific Conservation Biology* 15: 238-45.

Vivian, L.M., Doherty, M.D. and Cary, G.J. (2010). **Classifying the fire-response traits of plants: How reliable are species-level classifications?** *Austral Ecology* 35(3): 264-73.

Book Reviews

Australian Palms.
Biogeography, Ecology and Systematics

By John Leslie Dowe
CSIRO Publishing, Collingwood Vic., 2010
304 pages with colour photographs
Paperback, ISBN: 9780643096158, AU $140.00
Available from: www.publish.csiro.au



The palm family makes a relatively small contribution to the diversity of the total Australian plant species and to the tropical and subtropical flora but the diversity of landscapes in which it occurs is significant. Palms are found from the tropical coasts and hinterlands to the south-east forests, and disjuctly in the Central Australian river gorges and off-shore of Christmas Island, Norfolk Island and notably Lord Howe Island with its extensive groves of Kentia palm. The Kentia palm is one of the most commonly propagated and commercially sold palm species in Australia and overseas.

While the number of Australian palm species may be small, the family is diverse in form and includes representatives of all five palm sub-families.

Several very good books on Australian palms have been published over the past two or three decades by Jones and others but as the author of this book notes, it has been a very long time since the last broad systematic and taxonomic treatment of the Australian palm flora was published. This book by John Dowe is a timely update and a thorough revision of the descriptions of the genera and species of the Australian palm flora. It is also a worthy culmination of more than twenty years of research by the author.

Dowe details in the first section of the book (chapters 1 to 4) information on the botanical history, historical biogeography, distribution and ecology of the sixty species of Australian and nearby island palms.

The book is richly endowed with high quality photographs of the morphological features of all the species and subspecies, as well as very good maps of their locations and distributions. These photographs and maps will assist readers not confident in the use of botanical keys, but still wishing to recognise the individual species and their centres of occurrence and distribution.

In the second section (chapters 5 to 11) the author addresses the systematic arrangement of the Australian palm flora with descriptions of taxa from the subfamily to subspecies level. Unfortunately there is an erratum for figure 10.2 which should not occur in such a quality and costly publication. Fortunately it does not detract from the quality of the text.

In chapter 12 Dowe provides a concise key to the sixty species based on features of mature specimens that may be observed in the field. I found the key clear and accurate and it enabled ready field identification of all the species on which I tested it.

All sixty species are listed under twenty genera, in an up to date checklist, while a very good glossary explains the general and taxonomic terms used throughout the book. An excellent reference list is given in the latter pages of the book.

This a quality book and is a very useful field guide, but unfortunately it would be limited in this regard, as it is large-format, soft-cover book. A smaller hard-back version would be more appropriate for field use. Irrespective of this, the book should be on the shelves of all students and professionals interested in palm taxonomy and their distribution and occurrence, as it engenders a real 'feel' for the palm flora.

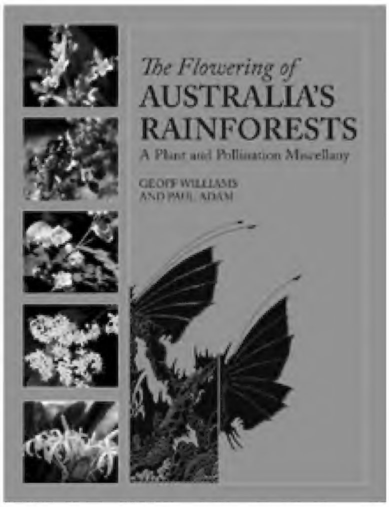
Like so many quality publications from CSIRO Publishing, the book is expensive and probably beyond the resources of most students; hence it should be in the libraries of all academic institutions where botany and ecology subjects are presented, as well as land management agencies responsible for areas where the palms occur.

Roger Good, Alpine Ecologist, Bungendore, NSW

Book Reviews (cont.)

The flowering of Australia's rainforests: a plant and pollination miscellany

By Geoff Williams and Paul Adam
CSIRO Publishing. 200 pages. ISBN: 577.340994.
$99-00 (incl. GST) + postage and handling.
Order on-line at www.publishcsiro.au or by
email: publishing.sales@csiro.au, or by phone 1300 788 000
(Australia only) or +61 3 9662 7666



As an absolute lover of all aspects of plant ecology, I find pollination ecology and breeding systems are fascinatingly complex, as well as being key components of a taxon's persistence and evolutionary potential. This book tantalises those fascinations.

The chapter titles and subtitles are enticing, with some delightful descriptions of what is to follow, such as "chemical warfare and the evolution of flowers", "attraction of the comely shape: orchid flowers and barren illusion" and "pollination syndromes: who brings the 'flower children' in rainforest?".

The preface sets the scene for the wonderful journey the reader is to be taken on. To use the authors' words "from time to time we have taken a circuitous path that too easily voyages to the shores of other lands, that finds interest in plants that do not belong solely or even tenuously to the rainforest environment…in this we mimic the ecosystems and the players to which we mean to attend…like the very ecosystems…we address, our story is a mosaic in the telling."

The journey begins with Chapter 1, "flowers and pollination in lore and legend", an anthropogenic view of the beauty, fascination, respect and dependence humans have for flowers and their pollinators. In Chapters 2 and 3 we are taken back in time, over 100 million years, to plants and pollinators no longer in existence, yet which through the evolutionary processes, are represented in the plants and insects present today.

The importance of this book to consultants, decision-makers, evolutionists, conservationists, and bush regenerators should not be underestimated. It has applicability to those studying other communities and plants with different breeding systems. The information is there for you to extract and put into a format that will be useful for your work or interest.

Successful restoration projects will depend on whether creating sustainable populations is one of the objectives, and whether in the collection, propagation and planting processes you have considered and understood the taxonomy, pollination ecology, breeding system, likely genetic status, and evolutionary potential, of the species and populations being respectively planted and created. Unfortunately, there are few examples in Australia where these aspects are adequately considered in restoration projects, and in areas such as northern NSW and south-eastern Queensland where most government funding for over 20 years has been toward rainforest restoration projects, these aspects are poorly considered, if at all.

This book has a large focus on NSW and Qld rainforests and rainforest species, a plethora of information useful for restoration and ecological assessments is provided. Appendix 1 discusses the conservation of rainforest. Chapter 4 "being a flower" describes the various features of different types of flowers and how they influence pollinators, and hence one can start the process of considering the likelihood of pollination success or failure, and appropriate planting arrangements.

Chapters 5, 6 and 7, and Appendices 4-6, build on pieces of the previous chapters, with an introduction to breeding systems, the mechanisms influencing pollination and reproductive ecology, and plant-pollinator relationships. Chapters 8 and 9, and Appendices 2, 3, 7, and 8 provide detailed accounts of pollinators.

If you have an understanding of, and interest in pollination ecology and breeding systems, and are familiar with rainforest plants you will find this an excellent and valuable resource, a pleasure to read, to pick up and have a flick now and then. For those with no or little understanding of pollination ecology and breeding systems, it may be handy to have a plant biology-ecology dictionary on hand.

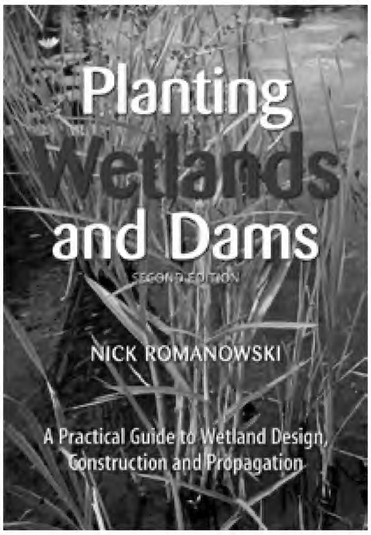
Other than lacking a glossary, which would have benefited non-botanists and non-plant ecologists, the only disappointment was the already published information in some of the appendices, which could have been more comprehensive through wider consultation. Despite this trivial criticism, this long overdue book, by two well respected ecologists in this field, will serve conservation and evolutionary ecologists and bush regenerators well.

Maria Matthes, Ecological Sustainability Consultant, Healing History, Bagotville, NSW

Book Reviews (cont.)

Planting Wetlands and Dams: A Practical Guide to Wetland Design, Construction and Propagation (2nd edition)

by Nick Romanowski
Publisher, Landlinks Press, Collingwood Vic., 2009
168 pages with colour illustrations
Paperback, ISBN: 9780643096363, AU $59.95
Available from: www.publish.csiro.au



Planting
Wetlands
and Dams
SECOND EDITION
NICK ROMANOWSKI
A Practical Guide to Wetland Design, Construction and Propagation

‘*Planting Wetlands and Dams: A Practical Guide to Wetland Design, Construction and Propagation (2nd edition)*’ largely lives up to the promise of its title. Drawing on over 30 years of experience in wetland design and wetland plant propagation, author Nick Romanowski has created a practical no nonsense step by step guide for the planning, designing, constructing and vegetating of new wetlands for current and future Australian environmental conditions.

With an easy to read plain English style Nick Romanowski takes the reader on a comprehensive step by step journey through the key considerations, practicalities and pitfalls of planning and building an open water wetland from scratch as well as for retrofitting and enhancing existing waterbodies such as farm dams to increase their wetland values.

The text is well structured and packed with helpful hints, facts and useful advice reinforced by clear explanations of the rationale and the science underpinning the recommendations. When it comes to contentious issues such as provenance and the ‘native vs exotic’ debate Romanowki is not afraid to take on existing mores and sacred cows and cogently constructs his arguments in support of his recommendations using the scientific literature and his extensive knowledge of wetland ecology.

This book is a call to arms to both conserve Australia’s remaining wetlands and to replace and replant wetlands in the landscape wherever possible. When it comes to wetlands and wetland restoration Nick Romanowski wears his heart on his sleeve. The exclamation marks which pepper the text reveal a man of conviction who is passionate about wetlands, is frustrated by their ongoing demise in the Australian landscape and is not afraid to speak his mind in their defence. His passion and enthusiasm for wetlands and wetland plants is infectious and suffuses ‘*Planting Wetlands and Dams*’. This helps to transform the book from what might otherwise simply be another dry technical manual into an engaging and at times entertaining journey in addition to be an excellent practical reference guide for those who are inspired to follow in his footsteps in restoring wetlands in the Australian landscape.

While the information is almost uniformly excellent throughout the book, the final chapter which provides information about the propagation of suitable plants for vegetating new wetland areas (*Plant information lists*) could have benefitted from the addition of more readily accessible practical advice to address the key questions raised in the previous chapter (*Planting out and problems*) such as which plant species or genera are most likely succeed in the harsh conditions of newly established wetland areas and which plants or plant genera are most appropriate for planting at which stage in the staggered planting regime recommended to increase the survivability of a more diverse range of wetland plantings in those harsh conditions. The utility of this section would be greatly enhanced by categorising plants according to their functionality in a staggered planting strategy rather than just alphabetically.

The utility of the guide is also let down at times by the book’s old fashioned text heavy formatting. The solid blocks of text would have been more attractive and functional if they were interspersed with the relevant photos, which are excellent but inconveniently lumped in the middle of the book. The text would also have benefitted at times from being more strongly supported with diagrams, check lists, examples and summary boxes illustrating and highlighting the key take home messages. However the text does provide further reading at several points in the book and it is possible these additions were beyond the scope and resources for the book.

Apart from these relatively minor criticisms ‘*Planting Wetlands and Dams: A Practical Guide to Wetland Design, Construction and Propagation*’ delivers on the promise of its title. The book is a comprehensive, authoritative, practical, accessible, engaging and easy to read guide to the planning, designing, constructing and vegetating of new and existing open water wetlands.

Michael Hensen, Biodiversity Conservation Officer, Blue Mountains City Council, NSW

Information Resources and Useful Websites

Leubner G (2010) The Seed Biology Place

http://www.seedbiology.de

An excellent and user friendly website that outlines a range of seed biology topics, including evolution, ecology, structure, plant hormones, dormancy and germination.

Brundrett MC. (2008) Mycorrhizal Associations: The Web Resource 2010

http://mycorrhizas.info/index.html

This site was developed as an online textbook to provide current information about mycorrhizal associations. It provides basic information with references and hyperlinks for more comprehensive information on symbiosis and mutualism, classification, morphology of associations and host plants. It includes an Australian section with information that can be used to help restore disturbed habitats and to understand interactions between plants, fungi and animals, and nutrient cycling in natural ecosystems.

Wildflowers of the Darwin Region

http://www.users.on.net/~bennnez/

Have fun exploring the botanical jewels of the Top End. This website is still under construction, but includes most of the more commonly seen, plus a few rare, plant species found in the Darwin region. The site has excellent photographs as identification aids to Top End flora using flower colour galleries. The key aim of the site is to give the observer a good introduction to genera rather than every species.

The Online Managed Realignment Guide (OMReG)

http://www.abpmer/omreg

This web-site seeks to include project-specific information about completed Managed Realignment and Regulated Tidal Exchange projects in North West Europe and, in so doing, to communicate the lessons learned in the past and thus, to improve the quality of similar projects in the future.

TREE OF LIFE web project

http://tolweb.org/tree/

The Tree of Life Web Project is a free online database that aims to compile information about every species and significant group of organisms on Earth, both living and extinct, and their evolutionary relationships. Contributors include an international suite of scientists, students and the general public. The project provides a useful tool for finding and sharing biodiversity information and resources, and for educational purposes.

Conferences and Workshops

Perth Urban Ecology Symposium: The ecology, management and restoration of natural ecosystem fragments in urban areas.

25-27 August 2010

Former extensive natural ecosystems are preserved in urban parks, reserves and other open spaces. Subject to many adverse impacts, the conservation of the natural values of these remnant ecosystems requires the successful integration of scientific knowledge and research with the management objectives of regional and local governments and activities of community groups.

The aim of this symposium is to provide a forum for presentation and discussion of recent developments in approaches to the management, conservation and restoration of natural ecosystem fragments in urban areas of the Australasian region.

Further information: http://www.environment.murdoch.edu.au/groups/ecology/workshop.html

TRIN Interactive Field Day

31 August 2010

Australian National Botanic Gardens, Canberra

The CERF-funded Taxonomy Research & Information Network (TRIN) are hosting an Interactive Field Day, aimed at those with an interest in identification products and biodiversity technology. The event provides participants with the opportunity to interact with TRIN researchers and developers, and consists of a series of exhibits and small presentations showcasing a variety of TRIN products and applications including: identification keys for mangrove plants, insect families, mayflies, rodents; management protocols for weeds and small vertebrates; sub-fossil bones and CT scanner technology; other resources and applications that support biodiversity management, such as the Atlas of Living Australia, Australian Plant Names Index and Australian Plant Census, and more.

Further information: http://www.taxonomy.org.au/fieldday.html

Conferences and Workshops

Australian Network for Plant Conservation Inc.
Translocation of Threatened Plants workshop
(Pottsville, Northern NSW)

Have you been involved in, or would you like to be involved in, the planning, approval or implementation of a translocation project for threatened flora? Then this workshop is relevant to you!

Questions to be addressed include:

- What is translocation?
- When is it appropriate to use translocation as a tool to conserve threatened species?
- What needs to be done when planning a translocation program?
- How should a translocation program be implemented?
- What ongoing management and evaluation is required?
- Where can I go for more information?

Where: Pottsville, Northern NSW
When: Friday 5 November 2010
Duration: One day

For more information or to register go to the ANPC website: www.anpc.asn.au or contact the ANPC office: anpc@anpc.asn.au or 02 6250 9509.

2010 NZPCN Conference
Plants in a human landscape – conservation outside of nature reserves

8-10 October 2010
Canterbury, New Zealand

Conference themes include 'The science of plant conservation', and 'Stopping the decline'. Symposia include: Threatened plants in a human dominated landscape, ecosystems – their status and classification, plant research on private land and hybridism and the science of restoration of human dominated landscapes.

Further information: http://www.nzpcn.org.nz

Postgraduate Workshop in Pollination Ecology

17-20 October 2010
Mt Hyland Wilderness Retreat, northern NSW

This hands-on workshop is being organised for students studying pollination ecology. Activities include demonstrations and discussions on methods in determining breeding systems, pollen flow, pollen libraries, pollen-tube growth, pollen germination, insect identification, pollinator networks, molecular tools, working with endangered species, non-invasive pollen sampling from mammals and insects and opportunities for student presentations. Costs: $950 for 3 nights, 4 days and includes accommodation, meals and course materials. Return transport from Armidale to the Retreat is available for $50 but seats are limited.

Further information and to pre-register interest for the workshop: contact Caroline Gross via the on-line site <https://www.surveymonkey.com/s/JWTYNXT>

2010 Australian Systematic Botany Society Conference
Lincoln, Canterbury, New Zealand

29 November - 3 December 2010

"Systematic botany across the ditch: links between Australia and New Zealand" including palaeobotany, biogeography, phylogeny, algae, hybridisation, and biosecurity/weeds.

Hosted by the Allan Herbarium, Landcare Research.

Further information: http://www.landcareresearch.co.nz/news/conferences/asbs2010/

Ecological Society of Australia Annual Conference
Sustaining biodiversity—the next 50 years

6-10 December 2010
Canberra, ACT

The conference will celebrate the 50th anniversary of the Society, during the International Year of Biodiversity. A series of themes will focus on the challenges that will be faced by Australian ecosystems over the next 50 years, and the way that our science will need to adapt to meet these challenges. The conference will take a long-term perspective of ecology in Australia and engender a sense of urgency to consider how ecologists can provide solutions to those problems with which we are now familiar, and those on the horizon.

Further information: http://www.esa2010.org.au

XVIII International Botanical Congress

23-30 July 2011
Melbourne, Vic.

Congress themes include: Systematics, evolution, biogeography and biodiversity informatics; Ecology, environmental change & conservation; Structure, development & cellular biology; Genetics, genomics & bio-informatics; Physiology & biochemistry; and Economic botany including biotechnology, agriculture & plant breeding. Keynote symposia under consideration include topics such as Climate change and adaptation; Evolutionary biology of land plants; Food production: challenges and solutions; Origins of Australian and southern flora; Plant biotic interactions (including plant–insect–fungi); Plant diversity and ecology; and Plant systematics in the 21st Century.

Further information: http://www.ibc2011.com/Program.htm

ANPC Corporate Members

ANPC gratefully acknowledges the support of the following corporate members

Albury Botanic Gardens, NSW

Approvals and Wildlife Division, Department of the Environment, Water, Heritage and the Arts

Australian National Botanic Gardens, ACT

Botanic Gardens of Adelaide, SA

Botanic Gardens Trust, NSW

Centre for Plant Biodiversity Research

Department of Environment and Conservation, WA

Dept of Sustainability and Environment, VIC

ForestrySA

Greening Australia, VIC

Mackay Regional Botanic Gardens, QLD

Redland City Council, QLD

Royal Botanic Gardens Melbourne, VIC

Royal Tasmanian Botanical Gardens, TAS

Sydney Olympic Park Authority, NSW

University of Melbourne, Burnley Campus, VIC

THE AUSTRALIAN NATIONAL BOTANIC GARDENS
is celebrating its 40th anniversary in October 2010

Friday 22 October – Black Tie Dinner under the stars in the Gardens
Sunday 24 October – ANBG Open Day and Garden Party

The Australian National Botanic Gardens champions plant conservation through

» providing technical advice and assisting in species recovery
» seed banking
» propagating rare and threatened species to support restoration ecology
» fostering learning and appreciation of Australia's unique flora

For further information about the ANBG's work and our 40th anniversary events in October 2010 visit www.anbg.gov.au/ or contact Visitor Information Centre on 02 6250 9540 or email anbg-info@anbg.gov.au

Australian Network for Plant Conservation Inc (ANPC)

8TH NATIONAL CONFERENCE

Planning conservation to achieving restoration:

A conference for everyone involved in conserving Australia's unique flora and native vegetation

28 September to 1 October 2010, Perth WA

DON'T MISS THIS NATIONAL CONFERENCE ON CONSERVING AUSTRALIA'S UNIQUE FLORA AND NATIVE VEGETATION

This conference is for practitioners, researchers, governments, community groups, non-government organisations and anyone else interested in plant conservation. We aim to provide updates on the latest, most relevant information, and opportunities to link up with other people working to conserve our native flora.

KEYNOTE SPEAKERS

Prof Richard Hobbs – University of Western Australia

Dr Kingsley Dixon – Botanic Gardens and Parks Authority Perth

INVITED SPEAKERS

Soil Health and Restoration

Prof Mark Tibbets – University of Western Australia

Dr Suzanne Prober – CSIRO Sustainable Ecosystems

Planning for Climate Change

Dr Colin Yates – Dept of Environment and Conservation WA

A/Prof Grant Wardell Johnson – Curtin University

Seeds and genes for restoration

Dr Linda Broadhurst – CSIRO, Division of Plant Industry

Dr Margaret Byrne – Dept of Environment and Conservation WA

Dr Seigy Krauss – Botanic Gardens and Parks Authority Perth

Dr John Koch – Alcoa

Role of Taxonomy

Dr Kevin Thiele – WA Herbarium, Dept of Environment and Conservation WA

Dr Judy West – Australian National Botanic Gardens, DEWHA

Engaging with Industry

Dr Steven Van Leeuwen – Dept of Environment and Conservation WA

Dr Libby Mattiske – Mattiske Consulting

Conservation Planning

Prof Bob Pressey – James Cook University

Prof Ladislav Mucina – Curtin University

IMPORTANT DATES AT A GLANCE

Registration open until 13 September

Welcome reception 27 September

Conference 28 and 29 September

Conference dinner 29 September

Mid-conference field trips 30 September

Informal dinner 30 September

Workshops 1 October

Post conference field trip 2 – 4 October

Further information can be found on the ANPC website: www.anpc.asn.au/conferences/2010/ or contact the ANPC office (anpc@anpc.asn.au; ph: 02 6250 9509)

Current Sponsors:

PLATINUM

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Taxonomy Research & Information Network
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Banksia brownii. Photo: David Coates

Calytrix breviseta. Photo: Andrew Crawford

Photo: Melanie Smith

Verticordia albida. Photo: Andrew Crawford

Banksia montana. Photo: Greg Freebury

Jacksonia pungens. Photo: Andrew Crawford

Australasian Plant Conservation
BULLETIN OF THE AUSTRALIAN NETWORK FOR PLANT CONSERVATION INC

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